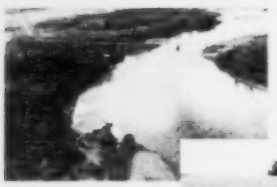
northern rivers ecosystem initiative

1998 - 2003



final report

2004

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northern rivers ecosystem initiative 1998 - 2003

final report
2004

Canada

Alberta

Northwest Territories

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Additional information on the Northern Rivers Ecosystem Initiative is available on the Internet at
http://www.pnr-rpn.ec.gc.ca/nature/ecosystems/index.en.html

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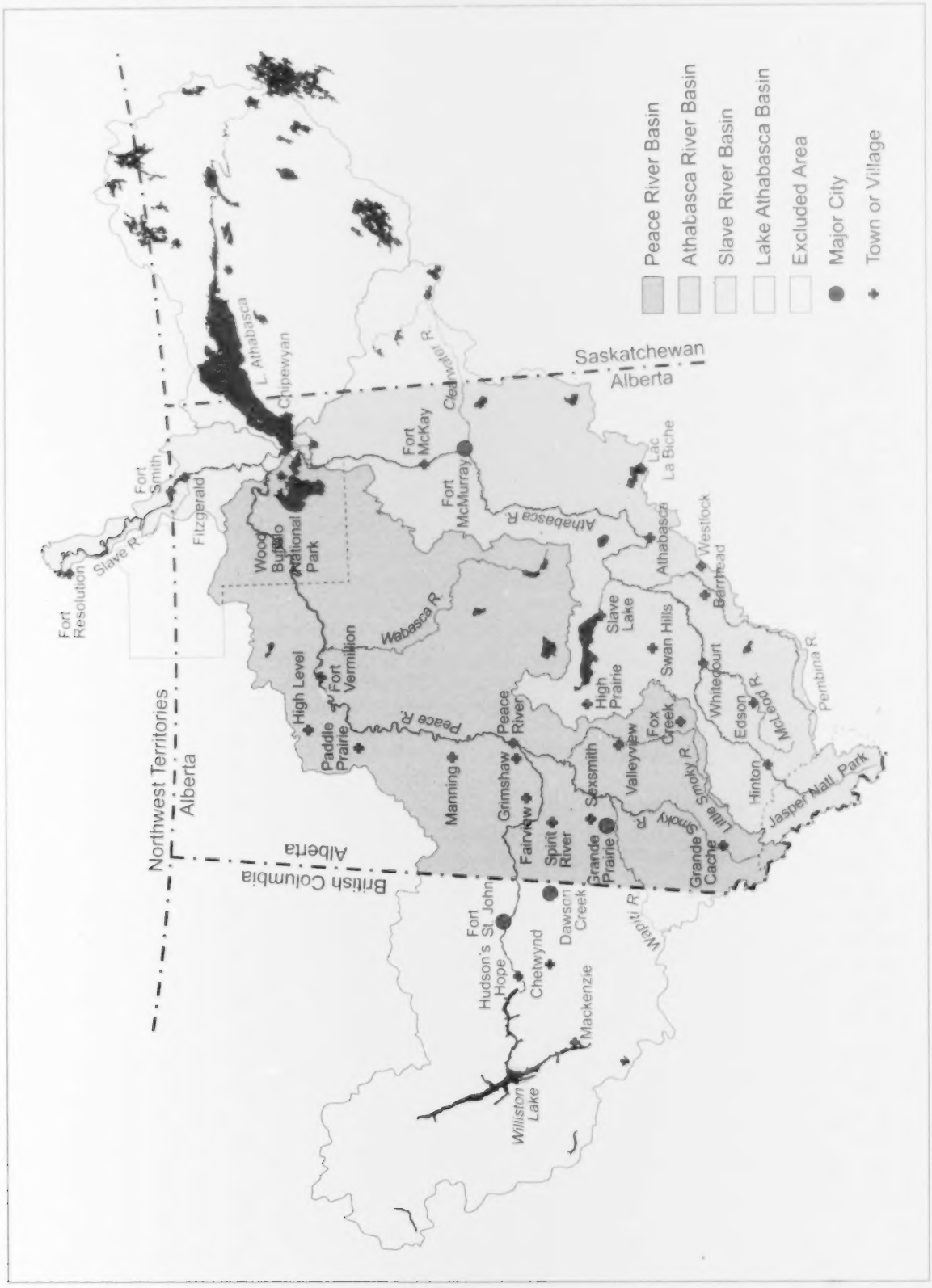
THE PEACE-ATHABASCA-SLAVE RIVER BASINS

THE PEACE-ATHABASCA-SLAVE RIVER BASINS



The Northern Rivers Ecosystem Initiative

"The Ministers, for a five-year period following completion of the Northern River Basins Study, report annually on the progress of implementing the research and management recommendations of this Report to the Ministers and the synthesis reports; that the annual summaries clearly describe the results of the ongoing research and management initiatives; and that the report be made available to the general public."

Northern River Basins Study, Recommendation 14, 1996

FINAL REPORT (JUNE 2003)

Actions to address the commitments made by Ministers in the *Canada-Alberta-Northwest Territories Response to the Northern River Basins Study* were undertaken, in a large part, through the **Northern Rivers Ecosystem Initiative (NREI)**. The Initiative, which began in 1998, was a cooperative 5-year endeavor by the governments of Canada, Alberta, and the Northwest Territories. The various follow-up actions to protect the northern rivers involved both policy initiatives and scientific research.

The three governments agreed it was very important to report progress as well as the results from implementing the responses to the recommendations. This final NREI progress report, along with previous progress reports (1999, 2001) contributes to meeting this commitment. Activities and outcomes were also reported periodically to basin stakeholders through the NREI newsletter, *River News*. Information is also available on the NREI website at: www.pnr-rpn.ec.gc.ca/nature/ecosystems/index.en.html

Several recommendations of the Northern River Basins Study were referred to the Mackenzie River Basin Board for their consideration and possible implementation. This Board was formally established in 1998 under the *Mackenzie River Basin Transboundary Waters Master Agreement*. The Steering Committee of the NREI met, on occasion, with representatives of the Mackenzie River Basin Board to discuss progress and issues of common interest.

The Northern Rivers Ecosystem Initiative has undertaken actions that address residents' concerns about the health of the aquatic ecosystem of the basins. Specific actions focussed on priorities such as pollution prevention, endocrine disruption in fish, hydrology, contaminants, nutrients, drinking water and enhanced environmental effects monitoring. The NREI involved scientists and resource managers from governments, universities, industry, and other organizations. Highlights of these actions are included in this report, with further detail available in various technical science reports. Although the focus of this final report is on NREI activities, highlights from other initiatives and issues in the northern river basins, of relevance to the recommendations from the Northern River Basins Study, are also presented.

> The **Northern River Basins Study** (NRBS) was a 5-year initiative launched by governments in 1991 to obtain further scientific information regarding the existing conditions in, and the effects of development on, the aquatic ecosystem of the Peace-Athabasca-Slave river basins. The NRBS was directed by a multi-stakeholder Study Board that made a number of recommendations to governments at the conclusion of the Study to help guide the management of the natural resources in the basins.

In addition to this report a companion document entitled NREI *Synthesis Report* was also prepared. This Synthesis Report provides a more detailed summary of all the science

and policy initiatives that have taken place within the northern river basins. This information is presented in the context of what is now understood with regard to the environmental health of the basin.

The Mackenzie River Board (MRBB), which was established in 1998, prepared a *State of the Aquatic Ecosystem Report* for the Mackenzie River Basin in 2003.

The MRBB report was based on indicators of climate change, contaminants, water quality, water quantity, in-stream uses, aquatic biota and human health as related to aquatic ecosystem health. Government monitoring programs, science-based studies and studies based on traditional ecological knowledge were used in the development of the indicators. Overall, the MRBB reported that aquatic ecosystems in the Mackenzie Basin, including the Peace, Athabasca and Slave River basins, were generally healthy. Nevertheless, the report identified several concerns related to climate change throughout the Mackenzie Basin, aspects of water quality in the Athabasca River and changes to flow regimes on the Peace River. The assessments of aquatic ecosystem health based on Traditional Ecological Knowledge were less favourable than those based on scientific assessments and government monitoring programs.

The following pages contain the recommendations from the Northern River Basins Study (1996), the response to those recommendations by the governments of Canada, Alberta and the Northwest Territories (1997), and a summary of NREI Progress Reports from 1999, 2001 and NREI activities up to March 31, 2003.

The NREI, which is the culmination of the NRBS, concluded as of March 31, 2003. This initiative, along with the NRBS, has contributed to a long-term legacy of environmental awareness and stewardship within the northern river basins. As such, a brief legacy statement is provided for each of the recommendations to provide some perspective on Governments' continued commitment to protecting the health of the aquatic ecosystem of the northern river basins.

NRBS RECOMMENDATION 1.1 (1996)

Regulatory agencies for the northern rivers declare and implement, through law, policy and practice, pollution prevention, including but not limited to zero discharge, as a primary environmental objective and as an important component of sustainable development.

"Limits for effluent discharges will be based on the most stringent of two approaches: either that required to meet ambient water quality objectives or that based on best available technology. Discharges are further minimized by optimizing the operation of individual treatment systems".

It is recognized that zero discharge is one means of achieving pollution prevention. However, zero discharge for all wastes in liquid effluents would be very difficult to achieve, and could result in other waste disposal challenges. Nevertheless, pollution prevention practices are becoming ever more stringent with time, resulting in the progressive reduction of point source contaminant discharges. The governments commit to maintaining this trend (Recommendations 1.2, 1.3, 1.4, 1.5 below).

The governments also acknowledge that non-point source inputs and atmospheric deposition of pollutants can be important, and commit to addressing these in pollution prevention strategies.

Governments' response to the recommendation (1997)

The governments of Canada, Alberta, and the Northwest Territories declare pollution prevention as a primary environmental objective and as an essential component of sustainable development. All three governments endorse the Canadian Council of Ministers of the Environment document *A National Commitment to Pollution Prevention* (November 1993).

Pollution prevention is implemented by means of federal, provincial, and territorial laws, regulations, and practices. Canada implements this commitment through its policy entitled *Pollution Prevention - A Federal Strategy for Action* (1995). Alberta manages wastewater discharges through its *Industrial Effluent Limits Policy* (December 1995).

NREI Progress Report 1 (1999)

- Revisions to the *Canadian Environmental Protection Act* (CEPA Bill C-32) were passed by the House of Commons in June 1999, and received Royal Assent on September 14, 1999.
- Air and water releases from industrial and municipal sources in Alberta are regulated by Canada's *Fisheries Act* and *Environmental Protection Act*, and comprehensive approvals under Alberta's *Environmental Protection and Enhancement Act* (EPEA).
- Site-specific licenses to discharge effluents to surface waters in the Northwest Territories are issued by the NWT Water Board under the provisions of the NWT *Water Act and Regulations*, which incorporates conservation and protection of the water resources as an underlying principle.
- Alberta Environment has applied the *Industrial Effluent Limits Policy* to set Total Suspended Solids (TSS) and Biochemical Oxygen Demand (BOD) limits for pulp mills on the Peace River, resulting in the implementation of technology-based limits which were determined to be more stringent than water-quality based limits at that location.
- Oil sand operations in north-eastern Alberta are required through their *Environmental Protection and Enhancement Act* approvals to report annually on initiatives to minimize and reduce all atmospheric emissions, such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2), from their mobile equipment and plant sources.
- A NO_x/SO_2 subcommittee, created under the industry-led *Cumulative Environmental Effects Management Initiative*, encourages industry, government and public stakeholders to design and implement an air emissions management system, which

includes environmental capacity guidelines, environmental management objectives, and an action plan to manage and control regional NO_x/SO_2 emissions associated with oil sands development.

NREI Progress Report 2 (2001)

- At their meeting in April 2001, the Canadian Council of Ministers of the Environment (CCME) endorsed Canada-Wide Standards for: mercury in fluorescent lamps; petroleum hydrocarbons in soil; and atmospheric releases of dioxins and furans from waste incinerators and coastal pulp and paper boilers. Canada-Wide Standards for particulate matter and ozone, mercury emissions from incinerators and base metal smelters, and benzene were endorsed in June 2000. A Canada-Wide Standard for mercury emissions from coal-fired electrical power generators is under development for spring 2002.
- Alberta Environment released the document *Industrial Release Limits Policy* (November 2000), which replaces *Industrial Effluent Limits Policy* (December 1995). The revised document contains the same principles as the 1995 version, and further extends the Policy for setting the release limits by determining the release limits required to maintain ambient air and soil quality; and secondly, determining the achievable release limits based on the capability of the most effective demonstrated pollution prevention and control technologies. The results of these two approaches are compared and the more stringent result is applied as the release limit.
- Alberta Environment is investigating alternative and innovative regulatory strategies through an initiative called *"Leaders in Environmental Approvals"*. Phase 1 investigated opportunities for more cost-effective ways to achieve environmental protection and pollution controls.
- Alberta Environment launched a Fluorescent Lamp and Computer Recycling Initiative in February 2001 with the objective of collecting and recycling the components, and to recover the mercury and lead from 75% of fluorescent lighting bulbs and computers sent to the waste stream from Alberta schools, health facilities and public buildings by 2005.
- In July 1999, regulators and stakeholders completed the *Regional Sustainable Development Strategy* framework design to manage the cumulative environmental effects of multiple developments in the Athabasca Oil Sands Area.
- A number of new oil sands plants were proposed in the year 2000 and were subject to the normal environmental assessment screening process. Additional considerations in the oil sands sector include:
  - Further work under the *Regional Sustainable Development Strategy* has been implemented to ensure environmental protection goals are met.
  - Applied research into a variety of treatment alternatives, such as consolidated tailings, wetland treatments and end-pit lake development is underway.
  - No direct discharge of industrial process waters into the Athabasca River is anticipated from the proposed new developments.
- With the goal of reducing pollution from non-point sources, Environment Canada and Alberta Environment are partnering with the Alberta Roadbuilders and Heavy Construction Association to examine the feasibility of developing a "best environmental practices" manual for the heavy construction sector.

NREI Update (2003)

- The extensive review and revision of CEAA, known as Bill C-9, *An Act to Amend the Canadian Environmental Assessment Act*, was given Royal Assent on June 11th, 2003 and was proclaimed on October 30, 2003. As part of this revision a new position – Federal Environmental Assessment Coordinator (FEAC) – was created to improve coordination among federal authorities and communication with other participants during the environmental assessment process. Additional information on the CEAA can be found at: http://www.ceaa.gc.ca/index_e.htm

- The Canadian Council of Ministers of the Environment (CCME) reaffirmed its commitment to clean, safe and secure water for all Canadians at its September 2001 meeting. The CCME recommended that each jurisdiction continue to maintain and improve standards for drinking water quality to protect the health and safety of all citizens.
- A document outlining the surface water quality guidelines for use in Alberta was released in 1999. This document updates and replaces previous Alberta water quality guideline documents and is the latest edition in an ongoing process of development, review and compilation of water quality guidelines. Further information is available at: http://www3.gov.ab.ca/env/water/swq/
- Alberta has a comprehensive environmental regulatory system. This system uses a number of tools, including Environmental Impact Assessments (EIAs) and approvals to assess, manage, and monitor the environmental effects of industrial development. The current regulatory system incorporates an adaptive management approach and requires the use of best available demonstrated technology.
- Alberta Environment continues to promote pollution prevention as the preferred approach to pollution control. Pollution prevention activities for the Alberta pulp and paper and oil sands sectors were summarized in the document *Pollution Prevention and Control: Industrial Initiatives in Northern Alberta*, July 2001. For details see: http://www3.gov.ab.ca/env/water/nrei/northern_rivers-alberta.html
- A Pollution Prevention and Conservation Section was created in Alberta Environment in 2002 to lead in the development of pollution prevention and stewardship programs. Alberta Environment will promote the practice of pollution prevention in all sectors and encourage voluntary actions of Albertans.
- During Phase 2 of the *"Leaders in Environmental Approvals Initiative"* industry, government and non-government stakeholders asked Alberta Environment to design a pilot project to test this new incentives-based approach. To assist with this, Alberta Environment developed the *Leaders Environmental Approval Document Program* (LEAD) and an accompanying LEAD Program Guide. Information on the pilot phase can be found at: http://www3.gov.ab.ca/env/protenf/approvals/factsheets/lead.html
- Pulp mill approvals will be coming up for renewal over the next 5 years. Alberta Environment will be conducting a detailed review of international standards for the pulp mill sector. Future standards in Alberta will be based on the *Industrial Release Limits Policy*, which requires that limits be set to ensure: that environment and human health are protected; the most appropriate pollution control technologies are adopted; and continuous improvement is sought.
- The AOX, Biochemical Oxygen Demand (BOD), and Total Suspended Solid (TSS) effluent loadings for the seven pulp mills in Alberta are illustrated in Figure 1. During the period 1990 to 2002 there was a decline in overall loadings, while pulp production continued to increase.
- All new oil sands projects are subject to an environmental assessment. As the unprecedented pace of development increases in the Athabasca oil sands region, new challenges – specifically the management of cumulative effects – are being placed on environmental management systems of government and industry.
- Four oil sands projects are currently in operation within Athabasca River basin, with a production of 735,000 barrels per day (b/cd). Two new oil sands projects have been approved within the basin since 2000 with a projected production of 250,000 b/cd. These oil sand operations, along with other production sites within Alberta, will produce almost one million b/cd, or 40-50% of Canadian crude oil production. Another five oil sand projects within the Athabasca River basin are currently undergoing environmental reviews.
- In June 2002, the Clean Air Strategic Alliance (CASA) published its *Pollution Prevention/Continuous Improvement Framework*. Alberta Environment co-chaired this project and is committed to addressing the report's recommendations. The document stresses the potential for

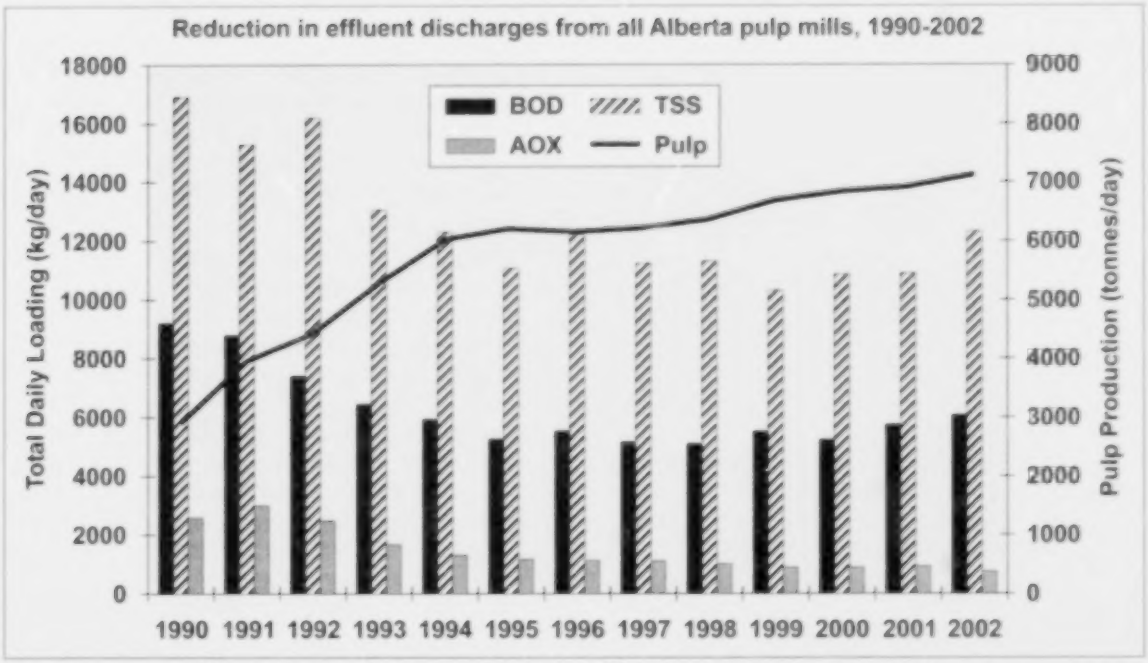


Figure 1 – *Effluent loadings have declined while pulp production has increased.*

pollution prevention to enhance air quality. Pollution prevention strategies that protect and improve air quality can also help to protect and improve water quality. Many contaminants such as mercury, acidifying emissions, dioxins and furans enter lakes and rivers as a result of atmospheric deposition. The CASA Framework document and other CASA reports are available at: http://www.casahome.org/uploads/P2CIFinalReportJUN-21-2002.pdf

- A CASA multi-stakeholder project team is close to finalizing its framework for the management of particulate matter and ozone in Alberta. This meets the requirements for implementation of the Canada-Wide Standard for particulate matter and ozone in Alberta. For more information refer to the CASA website at: http://www.casahome.org/
- The NO_x and SO_2 Management Working Group of the Cumulative Effects Management Association (CEMA) is tasked with developing management recommendations for NO_x and SO_2 emissions to prevent acidification in the region. Annual emissions of sulphur dioxide (1989-2002) from Syncrude Canada and Suncor Energy oil sand operations are illustrated in Figure 2.
- The Working Group has completed receptor sensitivity mapping for lakes/ponds, mineral soils and bogs/fens in northeastern Alberta. The level of protection is based on base cation to aluminum ratios (for soils) and acid neutralizing capacity (for water bodies). This work will define the environmental capacity to prevent acidification in the region. Further details are available at: http://www.cemaonline.ca/
- Federal, Provincial and Territorial governments are working with the Agricultural Industry to implement a comprehensive *Agricultural Policy Framework* (APF). The Framework includes an environmental element that recognizes that agriculture must function sustainably with the natural environment to ensure its long-term viability and profitability. Governments and industry are accelerating efforts to: reduce agricultural risks; provide benefits to Canada's water, soil, and air; and to protect bio-diversity. Details on the APF can be found at: http://www.agr.gc.ca/cb/apf/index_e.php

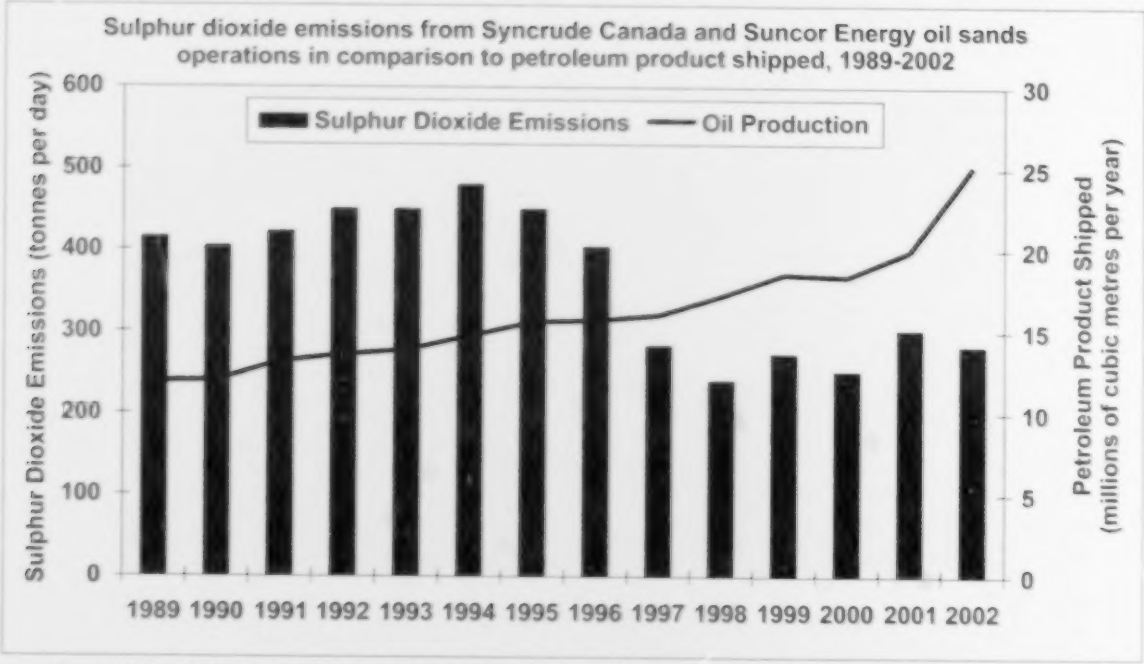


Figure 2 – *Oil sands sulphur dioxide emissions have declined while petroleum product shipped has increased.*

- Alberta's *Agricultural Operations Practices Act* (AOPA) came into effect on January 1, 2002, with the Natural Resources Conservation Board as the designated government agency responsible for approving confined livestock feeding operations under the regulations of the Act. A confined feeding operation also requires approvals and/or licences under other provincial legislation, including the *Water Act*, the *Public Lands Act*. Further details are available at: http://www.nrcb.gov.ab.ca/web/feeding/index.cfm
- Highlights from the first year of regulatory activity under AOPA can be found at: http://www.nrcb.gov.ab.ca/web/pdffiles/NRCB2002_03Highlights.pdf
- Alberta Environment is reviewing its grant programs for regional waste management and recycling systems in order to promote innovative approaches to solid waste management. Many poorly sited and designed waste management facilities have been closed.
- The *Waste Control Regulation* of the *Environmental Protection and Enhancement Act* is currently being reviewed with the objective of enhancing the regulatory structure of solid waste management to include updated standards, policies, and regulations.
- Alberta Environment, in partnership with Environment Canada and the Alberta Roadbuilders and Heavy Construction Association, completed a report *"Pollution Prevention Manual for the Alberta Roadbuilders and Heavy Construction Association, 2002"* which is available at: http://www.albertaroadbuilders.com/
- Phase Two of the Alberta Fluorescent Bulb and Computer Recycling program was launched in June, 2002 for the Industrial, Commercial and Institutional sectors. More than 120 organizations and businesses have signed on as partners. Over 2,000,000 kilograms of computer waste and 465,000 metres of fluorescent bulbs have been recycled since the inception of the program. Participating organizations are listed on the "Action on Waste" website: http://www3.gov.ab.ca/env/waste/aow/flcr/
- Alberta Environment partnered with the Clean Air Foundation, Environment Canada, the Alberta Automotive Recyclers and Dismantlers Association, MAXUS Technologies Inc., and the Recycling Council of Alberta to launch a program called *Switch Out* in June 2003. This program will encourage the removal of

mercury switches from retired vehicles to prevent mercury from being released into the environment. Each switch contains approximately 0.8 grams of mercury. Cumulatively, this amounts to over 13 tonnes of mercury in vehicles on the road in Canada today. About 700 kilograms is released into the environment every year when vehicles are scrapped and the steel recycled.

- CCME has committed to the development of Canada-Wide Standards for the reduction of mercury emissions from coal-fired electric power generating plants by 2005. The details can be found at: http://www.ccme.ca/assets/pdf/mercury_epg_notice_9june03_e.pdf
- An agreement has been negotiated with the Canadian Dental Association to implement a 95% reduction in the disposal of mercury (in dental amalgams) to municipal sewage systems by 2005.
- Alberta-Pacific Forest Industries Inc. received the *2002 CCME Pollution Prevention Award* under the category of Greenhouse Gas Reductions. Their reduction initiative included the use of wood waste energy sources to produce process steam and electricity for their mill's energy requirements, rather than utilizing natural gas. They also established a forest carbon sequestration sink using hybrid poplars planted on agricultural land. Other initiatives include working with the energy sector to reduce deforestation by minimizing seismic exploration lines, well site openings and road access.
- Alberta-Pacific Forest Industries, Inc. and Ducks Unlimited have formed a new watershed-based conservation partnership for the AL-Pac Forest Management Area (FMA). The goal is to achieve ecosystem health and sustainability of development through a comprehensive, proactive, watershed-based approach. The partnership will define and implement best practices in protection, restoration, enhancement, and the special management of priority watershed features. A GIS-based decision support system will be developed for use in planning all potential activities affecting the FMA area. Both partners will contribute funding and resources to the initiative. The participation of government, aboriginal and ENGO partners has also been enlisted.
- Alberta Environment is leading the implementation of *Water for Life: Alberta's Strategy for Sustainability*, Alberta's new initiative for water management. *Water for Life* outlines key directions, specific strategies and actions to manage Alberta's water resources more effectively. Information is available at: http://www.waterforlife.gov.ab.ca/

NREI Legacy

Pollution prevention and continuous improvement remain as important principles guiding government regulatory activities aimed at controlling pollution and protecting the environment. The Canadian Council of Ministers of the Environment (CCME), the major intergovernmental forum in Canada for discussion and joint action on environmental issues, is committed to collectively establishing nationally-consistent environmental standards, strategies and objectives to achieve a high level of environmental quality. Cooperative efforts between the Federal, Provincial and Territorial governments have proved to be very successful in protecting the environment. Point source discharges of dioxins and furans to water, for example, have been the target of aggressive federal and provincial regulation, as well as industry innovation and change, resulting in discharges of dioxins and furans to the aquatic environment declining dramatically over the past decade. In addition, there has been a commitment by industry to be more proactive, by contributing to and supporting partnerships that are committed to achieving ecosystem health and sustainable development in the northern river basins.

Although environmental regulations have proven to be an important mechanism for controlling pollution and protecting the environment, they are not static. Regulatory reviews and updates are a necessary and appropriate component of governments' commitment to sustainable development. Recent amendments to the *Canadian Environmental Assessment Act* (Recommendation 6) and current reviews of Alberta's *Environmental Protection and Enhancement Act* reflect their ongoing commitment to the environment.

NRBS RECOMMENDATION 1.2 (1996)

For contaminants;

a. *The objective be achieved within ten years for persistent toxic substances, to eliminate their use, generation or discharge with respect to the northern rivers.*

b. *Implementation begin by "capping" direct loadings into the rivers of persistent toxic substances at 1996 levels.*

c. *An open, credible process be employed to: (i) identify substances or test for substances within the category; (ii) develop a timetable for a step down to elimination; and (iii) determine ways in which the step down may be achieved. This should be accomplished with reference to the definition of persistent toxic substances and process contained in the* Canada Toxic Substances Management Policy *(June 1995).*

Governments' response to the recommendation (1997)

The governments agree that elimination is the ultimate goal for persistent and bioaccumulative toxic substances, and note that work toward this goal has already been implemented for dioxins, furans and PCBs. Persistent toxic substances refer to those compounds that are toxic, accumulate in plants and animals, do not readily breakdown in the environment and originate as a consequence of human activities.

Direct loadings of dioxins and furans to the northern rivers have come mainly from bleached kraft pulp mills. In Alberta, the generation and discharge of these contaminants have been significantly reduced in the last several years as a result of technology improvements, specifically at the Weldwood plant at Hinton and the Weyerhaeuser plant at Grande Prairie. Further reductions are being sought from the Daishowa-Marubeni mill at Peace River. The Alberta Pacific mill near Athabasca does not have detectable amounts of these substances in its effluent. The net result is that direct loadings of these substances to the northern rivers will continue to decline, even from 1996 levels. NRBS studies have confirmed that levels of dioxins and furans have now been significantly reduced in fish tissue as a result of these improvements.

Toxaphene, a persistent toxic pesticide, was also reported by NRBS to occur in the food chains of the northern river basins. It probably reaches the basins by long-range atmospheric transport. The sources of this pesticide are external to the basins and believed to be external to Canada. Therefore, control of toxaphene will be pursued by Canada through international mechanisms (Recommendation 1.5).

Mercury is bioaccumulative and persistent, and was detected by NRBS in several fish species at various locations throughout the basins. NRBS was unable to characterize any significant, single, point source of mercury. The governments commit to long-term monitoring of mercury and other contaminants in fish tissue and to the associated assessments of human health implications (Recommendation 12).

The governments also note the concern expressed by the NRBS Board concerning polychlorinated biphenyls (PCBs). This class of contaminants is currently regulated and there are no known point sources in the northern basins. Therefore, the generation or discharge of these contaminants appears to have been eliminated. Nevertheless, Alberta and Canada will conduct further site-specific investigations of PCB contamination issues identified by NRBS (Recommendation 13).

The objective of the federal *Toxic Substances Management Policy* is the virtual elimination of persistent, bioaccumulative, toxic substances. Alberta will use its *Environmental Protection and Enhancement Act* and its *Industrial Effluent Limits Policy* to implement reductions of these contaminants and to continue to progress toward elimination. Canada will use the *Canadian Environmental Protection Act*, the *Fisheries Act* and the *Toxic Substances Management Policy*.

The Alberta *Environmental Protection and Enhancement Act* process and the federal Policy both allow for public review and input to the regulatory control of such contaminants. Alberta reports on the effectiveness of effluent discharge regulation by issuing periodic data summaries entitled *Alberta Industrial and Municipal Effluent Quality Monitoring*.

NREI Progress Report 1 (1999)

- A revised *Canadian Environmental Protection Act* (CEPA Bill C-32) received Royal Assent in September 1999.
- In January 1998, all jurisdictions of the Canadian Council of Ministers of the Environment (CCME), including Alberta and the Northwest Territories, signed the *Policy for the Management of Toxic Substances*, which builds upon the *Canada Toxic Substances Policy (1995)*.
- Under the Environmental Effects Monitoring (EEM) provisions of the *Canada Fisheries Act*, pulp mills are required to monitor and report on the impacts of their effluents on the receiving streams.
- Alberta began an evaluation of its industrial point-source regulatory standards for a wide range of contaminants relative to standards from other jurisdictions.
- Weldwood, Weyerhaeuser, and Alberta Pacific Forest Industries are utilizing process technologies (i.e., oxygen delignification and/or elemental chlorine-free bleaching) which reduce or eliminate the formation of dioxins and furans.
- The most toxic form of dioxins (2,3,7,8-TCDD) were not detectable in 1997 and 1998 from the four bleached kraft mills in Alberta and furan levels remained below federal government limits (50 parts per quadrillion).
- Renewal of Daishowa-Marubeni International's approval under the *Environmental Protection and Enhancement Act* requires the company to install elemental chlorine-free bleaching process by the year 2000.
- Further site-specific investigations of PCB contamination, as identified in the NRBS, were conducted in 1998 by Alberta and Canada (Recommendations 10.3 and 13). Although both governments and industry have undertaken additional monitoring of sediments, fish and effluent discharges, no point sources have been identified.
- Under the NREI, Canada and Alberta have begun a study of persistent contaminants in fish in river reaches downstream of the pulp mills at Hinton and Grande Prairie, with results to be compared with those observed during the NRBS.
- Alberta Environment maintains a large number water quality monitoring sites in the northern basins in order to assess the effectiveness of the regulatory processes in protecting the rivers.

NREI Progress Report 2 (2001)

- Daishowa-Marubeni International Ltd. converted its Peace River pulp mill to 100% chlorine dioxide substitution (also know as Elemental Chlorine-Free or ECF Bleaching) in 1999.
- Weyerhaeuser's Grande Prairie pulp mill has committed to installing oxygen delignification process equipment by 2002, which will further reduce the potential for formation of chlorinated dioxins and furans.
- The public health management committee established by Alberta Health and Wellness conducted a thorough review of all the factors involved with the dioxin/furan levels in fish taken from Smoky and Wapiti rivers and concluded there was minimal risk to the public regarding the consumption of mountain whitefish. Therefore, in November 2000, a ban on the consumption of mountain whitefish from the Smoky/Wapiti river system was modified to allow limited consumption. As an added precaution pregnant women and young children should avoid consumption of mountain whitefish.
- NREI studies currently being conducted by Environment Canada on dioxin and furan levels in burbot livers from the Wapiti, Smoky and Peace rivers confirm a major decline in these contaminants from 1990 to 1995, followed by no significant change from 1995 to 1998.
- On the upper Athabasca River, studies of mountain whitefish indicate a significant decline in dioxin and furans downstream of Hinton between 1992 and 1998.
- NREI research indicates that Toxaphene remains a contaminant of concern in burbot liver in the Athabasca River, but not in the Wapiti River.
- During 1999-2000 further full-congener analyses for PCBs were carried out by Alberta Environment on sediment samples from the Wapiti, Smoky, and Peace rivers.

- All sample concentrations from the Wapiti and Bear rivers are well below CCME sediment guidelines, but relatively higher PCB concentrations were found downstream of Grande Prairie than upstream and, in particular, the Bear River displayed elevated concentrations – suggesting a potential urban source.

- During the NRBS, elevated PCB concentrations in sediments were detected in the Peace River upstream of its confluence with the Smoky River. However, new results from 1999-2000 on samples from both rivers near their confluence revealed negligible concentrations at either site. It is likely that the NRBS results showing elevated PCBs in the mainstem Peace River were anomalous.

- Environment Canada is conducting further testing for PCBs and other contaminants in water and suspended sediment from the upper reaches of the Athabasca River. Testing was also conducted on sediment samples from the upper Athabasca River to identify potential sources of low-level PCB contamination found in fish tissue during the NRBS.

NREI Update (2003)

- In 2001 the Canadian Council of Ministers of the Environment endorsed Canada-wide standards for emissions of dioxin and furans from waste incineration.

- Concentrations of dioxins and furans in suspended sediment samples collected from the Athabasca River in 2001 are significantly lower than the levels measured in 1992.

- Spatial patterns for dioxins and furans in suspended sediment were difficult to define; however, there was a suggestion of a human induced trend on the Wapiti River.

"Contaminants in water and suspended sediment particles from specific reaches of the Peace Athabasca System" (Alaee *et al.*, 2004).

- Sampling and analyses conducted since the last progress report indicate that total (Σ)PCBs in water and suspended sediment are present at low concentrations in the Athabasca and Wapiti rivers, but tend to be higher downstream of developed areas.

- Bottom sediment samples collected from the upper Athabasca River in 2000 revealed ΣPCB concentrations well below the CCME *Interim Quality Sediment Guidelines* (IQSG). However, ΣPCB concentrations in Hardisty Creek, which flows through the town of Hinton and into the Athabasca River, were an order of magnitude higher than the remaining sites on the Athabasca River.

"Investigation of poly-chlorinate biphenyls in bottom sediments of the Bear-Wapiti-Smoky-Peace and upper Athabasca river systems, 1989-2000" (Hazelwinkel and Noton, 2004).

- A multi-variate analysis of bottom sediment data collected in 1999 revealed that the PCBs detected in the Bear Creek are of a different type than those detected in the Wapiti, suggesting different sources.

- These results suggest potential urban sources of PCBs for both the Wapiti (Bear Ck.) and Athabasca (Hardisty Ck.) rivers.

"Spatial and temporal trends of organochlorine contaminants in fish from Alberta's Northern Rivers" (Muir and Fraikin, 2004).

- ΣPCBs in burbot liver samples obtained from the Wapiti River downstream of Grande Prairie remain unchanged since 1992 and continue to exceed concentrations in burbot liver from the Athabasca River, Great Slave Lake and the Mackenzie River.

- ΣPCB concentrations in burbot liver from the upper Athabasca River were also relatively high (compared to all other sites, except the Wapiti River) and also remain unchanged.

- ΣPCB concentrations in muscle tissue of burbot, mountain whitefish, bull trout and long nose sucker from the Athabasca river system are relatively low and thus do not pose a concern from the viewpoint of human exposure.

- As reported previously, dioxins and furan have shown marked declines in concentrations in muscle tissue in burbot, mountain whitefish and longnose suckers

in the upper Athabasca river system and in burbot near Grande Prairie on the Wapiti River. These declines further reflected the success of new treatment technologies instituted by the pulp and paper industry since the early 1990s.

- On the Wapiti River, the rate of decline in TCDD toxic equivalents (TEQs) in burbot liver leveled off in the late 1990s because concentrations of dioxin-like PCBs remained relatively high, and unchanged, over an 8 year period (1992-2000).
- As a result of this new information fish consumption advisories for the Athabasca River have been modified (Recommendation 12).
- Toxaphene was identified as a contaminant of concern in the second progress report. New data indicate that toxaphene levels in the Wapiti and upper Athabasca rivers are low in burbot livers. This spatial pattern suggests that toxaphene originates from diffuse sources, likely related to long-range atmospheric deposition.
- Considerably higher toxaphene levels were reported for burbot livers in Great Slave Lake. These new results suggest that large northern lake ecosystems accumulate contaminants differently. Further monitoring and investigation would be required to clarify these patterns.

"Contaminant biomagnification in specific reaches of the Peace-Athabasca river ecosystem - Study Highlights" (Evans and Muir, 2004).

- Preliminary evaluations of a wide range of other industrial and agricultural contaminants in liver and muscle tissue from various fish species, zoobenthos and periphyton were also included in the NREI studies. Various spatial patterns were observed but interpretation of the patterns is complex. Sources of these contaminants may include long-range atmospheric deposition, local agricultural activities and industrial processes within the basin. The presence of these contaminants confirms the vulnerability of the northern river basins to impacts from sources within and external to the basin.
- Preliminary results of food web investigations suggest a strong correspondence in the spatial patterns of PCB concentrations in burbot livers, zoobenthos, and forage fish. The primary causal factor is thought to be the accumulation and retention of PCBs in the periphyton-rich upper reaches of these rivers.

NREI Legacy

Both the Northern River Basin Study (1990-1996) and the Northern Rivers Ecosystem Initiative (1998-2003) have provided important insights into the sources of persistent contaminants and their environmental abundances and distributions. The NREI has clearly demonstrated that the trend in point source loading of several persistent toxic substances (dioxins, furans and toxaphene) have been substantially reduced by pollution prevention actions or by natural ecological processes. The continued presence of some of these toxic substances in fish tissue (e.g., PCBs), however, remind us of the persistent nature of these substances in the ecosystem and the need for ongoing vigilance.

NRBS RECOMMENDATION 1.3 (1996)

For nutrients;

a. *The objective be achieved within a reasonable period of time for nutrients, to eliminate or substantially reduce their discharge to the northern rivers, consistent with environmental management objectives.*

b. *Implementation begin by "capping" direct nutrient loadings into specific reaches of the rivers, as indicated by the Study's findings.*

c. *An open, credible process be employed to: (i) identify environmental management objectives with respect to nutrients; and (ii) develop a plan to reach those environmental management objectives.*

Governments' response to the recommendation (1997)

The governments agree with the need for nutrient control and will continue to seek reductions in point-source discharges of nutrients. Through its *Environmental Protection and Enhancement Act* approvals process, and under the Industrial *Effluent Limits Policy* (1995), Alberta is requiring pulp mills to develop and implement nutrient reduction programs.

Nutrients are added to pulp mill wastewater treatment systems to optimize microbial breakdown of organic wastes. There will, therefore, always be small concentrations of nutrients in effluents but the reduction programs will bring these amounts down to levels equivalent to those typically obtained by tertiary treatment.

The governments will develop water management plans for the long-term protection of these rivers which will include reach-specific objectives for controlling nutrients (Recommendation 10.1). The development of these plans will include consultation with stakeholders and the general public.

To ensure the long-term protection of selected river reaches identified by NRBS, certain municipalities will also be required to implement tertiary treatment for nutrients. This requirement will be applied to Grande Prairie during its forthcoming *Environmental Protection and Enhancement Act* Approval renewal. The sewage treatment plant at Jasper townsite is also undergoing review and modification to improve nutrient control (Recommendation 2.5). In the Northwest Territories, the NWT Water Board has issued environmental management objectives for municipal sewage discharges and sets site-specific requirements in water licences. The approval processes for controlling all of these discharges are open to the public.

The relationships between river biota and nutrient concentrations are very complex. The governments agree that such knowledge is a fundamental component of water management plans. Accordingly, Canada and Alberta have agreed to pursue joint research efforts to understand and quantify these relationships (Recommendations 2.5 and 10.1). The federal government is conducting an extensive review of the impacts of municipal effluents and nutrients on Canadian aquatic ecosystems. The results of this review will be pertinent to the northern rivers and the development of water quality guidelines.

NREI Progress Report 1 (1999)

- Research is being undertaken by Environment Canada and Alberta Environment through the NREI to examine whether elevated nutrient concentrations, as identified during the NRBS, are indirectly affecting dissolved oxygen concentrations to a degree that is detrimental to the northern rivers.
- The federal government is conducting an extensive review of the impacts of municipal effluents and nutrients on Canadian aquatic ecosystems.
- Considerable data collection and interpretation has been undertaken by Alberta Environment in support of developing reach-specific nutrient guidelines for the northern rivers including:
  - benthic algal biomass and water chemistry surveys of the Athabasca, Wapiti and Smoky rivers;
  - a nitrogen assessment on the Wapiti River near Grande Prairie, and;
  - a request for all pulp mills to collect nutrient and benthic algal biomass data, in addition to the base requirements of the federal

Environmental Effects Monitoring Program.

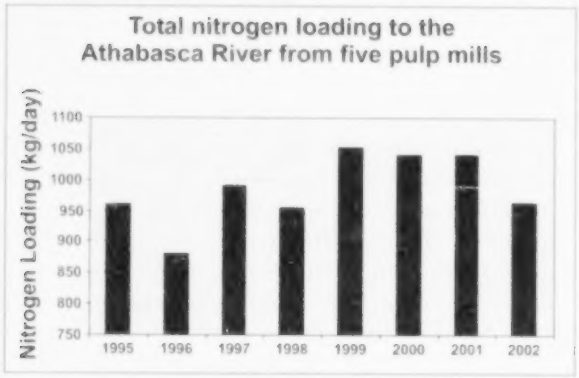
- Average nitrogen loadings from the pulp mills on the Athabasca River between 1995-1998 have been variable with no noticeable trend, whereas phosphorus loadings have shown a steady increase. Pulp mill approvals in Alberta have required the mills to conduct studies into ways to reduce their industrial wastewater pollutants, including nutrients, and Alberta Environment will continue to work with the pulp mills to evaluate all options for nutrient control.
- The City of Grande Prairie has announced plans to improve its treatment system to reduce nutrients and organic discharges. These plans will be reflected in the city's wastewater approval to be renewed in the fall of 1999.
- In the Northwest Territories limits for nutrients are included in mining and municipal licenses.
- Studies have been initiated as part of the NREI to provide scientific support for nutrient guideline development. A literature review and scientific assessment of the relationship between nutrient concentrations and the resulting impacts on primary productivity and secondary biological production in northern river systems has been initiated. A study was also initiated on the Wapiti River to assess benthic algal growth in relation to water chemistry associated with different land uses in the basin.

NREI Progress Report 2 (2001)

- Environment Canada released a draft report in November, 2000, *"Nutrients and Their Impact on the Canadian Environment"*, that deals with the regulation of nutrients in Canada. A national workshop was subsequently held in March 2001 to review the state of scientific knowledge and regulatory approaches for the management of nutrients in Canada.
- Between the period of 1995 and 2000 average total phosphorus loadings from the five pulp mills on the Athabasca River demonstrated an increasing trend, and Alberta Environment will be working with the pulp mills to evaluate all options for nutrient control.
- An NREI research project to quantify nutrient-plant relationships in the northern rivers was successfully implemented in the year 2000, with detailed field studies conducted on the Wapiti River.
- The City of Grande Prairie is improving its treatment system to reduce both nutrients and organic discharges.
- Construction of the new wastewater treatment plant for Jasper is scheduled to begin in the spring of 2001, with completion expected in late 2002.
- Alberta Environment continues long-term monitoring of nutrients and plant biomass at a number of strategic locations in the northern rivers, and data from this as well as NREI studies will contribute to the development of reach-specific nutrient guidelines.

NREI Update (2003)

- In 2001 the Government of Canada published a comprehensive review on the nature and extent to which nutrients derived from human activities impair Canadian ecosystems and affect the quality of life and health of Canadians. A report entitled *"Nutrients in the Canadian Environment"* is available at: http://www.ec.gc.ca/soer-ree/English/SOER/nutrients.cfm
- Alberta Environment continues long-term monitoring of nutrients at a number of strategic locations in the northern river basins. Phosphorus concentrations at two of these long term locations are presented in Figures 4-7. Trend analyses conducted on total phosphorus data for these two sites for the years 1973-2002 inclusive indicate that no statistically significant change has occurred. However, analyses on dissolved phosphorus, the more biologically available fraction, indicate a statistically significant increase between 1978 and 2002 at the Athabasca site.
- The total nitrogen loadings from pulp mills to the Athabasca River have not increased since 1999 (Figure 3 Total Nitrogen from pulp mills). Total phosphorus loadings, however, have continued to increase since 1995.



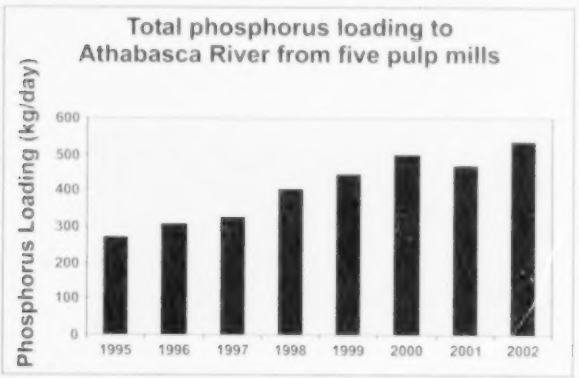


Figure 3

- Effluent loads further indicate that the ratio of phosphorus per unit pulp production is higher and has increased steadily at the CTMP mills during the 1995-2002 period, whereas the ratio is lower and has remained consistent at the Kraft mills. These trends reflect the increased use of phosphorus to control BOD discharges as pulp production increases.
- The release of nutrients (phosphorus and nitrogen) by the pulp mills and the need to control the releases is being reviewed in the context of the results of the *Environmental Effects Monitoring* (EEM) *program*.
- AENV will continue to work with the pulp mills to evaluate all options for nutrient control to ensure that pulp mills do not use any more nutrients than is required to optimize the performance of their wastewater treatment systems. All EPEA approvals can be viewed at: http://www3.gov.ab.ca/env/water/ApprovalViewer.html
- The new municipal wastewater treatment system at Jasper, consisting of biological nutrient removal with UV disinfection, was completed in February of 2003 and is now fully operational.
- The City of Grande Prairie has implemented a two phase upgrading of its wastewater treatment plant. The first phase, completed in the fall of 2001, consisted of the construction of a biological nutrient removal system. Phase two, scheduled for completion in 2008, will include an expansion of the biological nutrient removal system and implementation of UV disinfection.
- The current EPEA approval for the City of Ft. McMurray's waste water treatment facility requires the municipality to submit engineering proposals to upgrade the system to tertiary treatment levels.

"Setting Nutrient Guidelines for the Northern Rivers of Alberta" (Chambers and Guy, 2004).

- The NREI project to evaluate nutrient/algal relationships has demonstrated that benthic algal biomass in the Athabasca and Wapiti rivers is a predictable function of nutrient concentrations as well as other major variables such as river discharge, turbidity and suspended solids. Individual regression models were developed for each of the four eco-regions comprising the Athabasca and Wapiti rivers. These models were used to propose draft guidelines for phosphorus and nitrogen concentrations, with the goal of not exceeding the 75th percentile for reference benthic chlorophyll *a* concentrations.

"Mesocosm Assessment of Pulp Mill and Municipal Sewage Effluent Effects on Benthic Food Webs and Longnose Dace (Rhinichthys cataractae) of the Wapiti River, AB" (Culp *et al.*, 2004).

- Experimental mesocosm studies on the Wapiti River as well as the *in situ* studies on the Wapiti and Athabasca rivers have illustrated the complex nature of nutrient dynamics and limitation patterns for these systems. These new results underline the potential importance of both nitrogen and phosphorous as limiting factors in these rivers.

MEDIAN AND RANGE OF PHOSPHORUS CONCENTRATIONS AT ATHABASCA

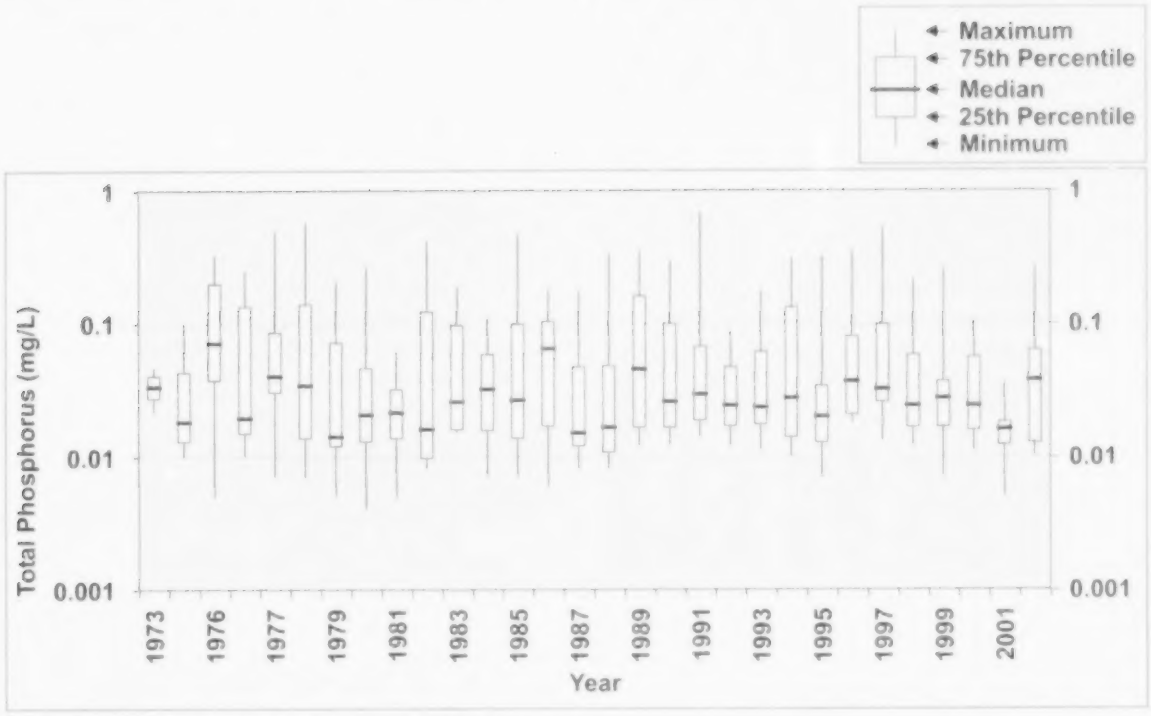


Figure 4 – *Total phosphorus at Athabasca*

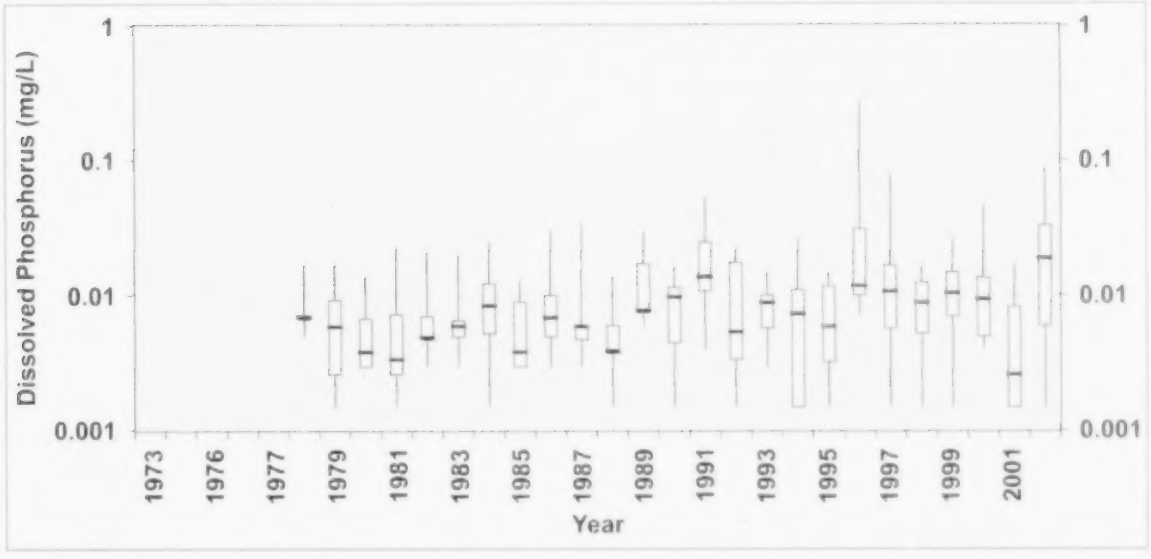


Figure 5 – *Dissolved phosphorus at Athabasca*

recommendations

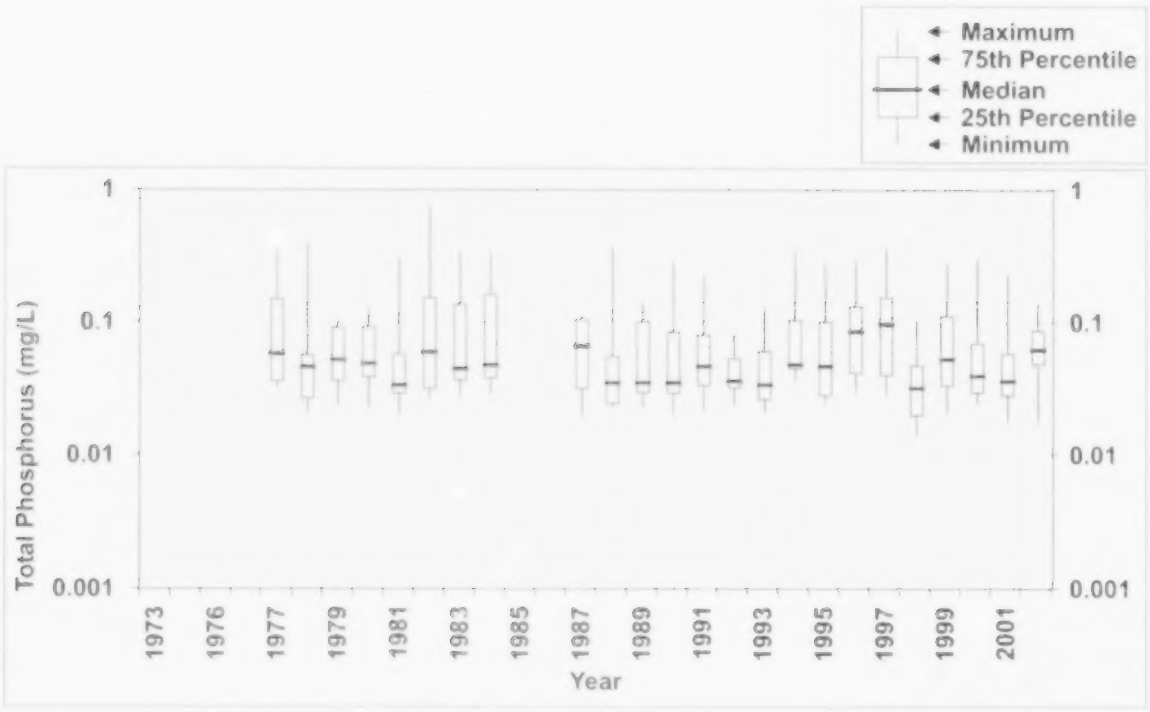


Figure 6 – Total phosphorus at Old Fort

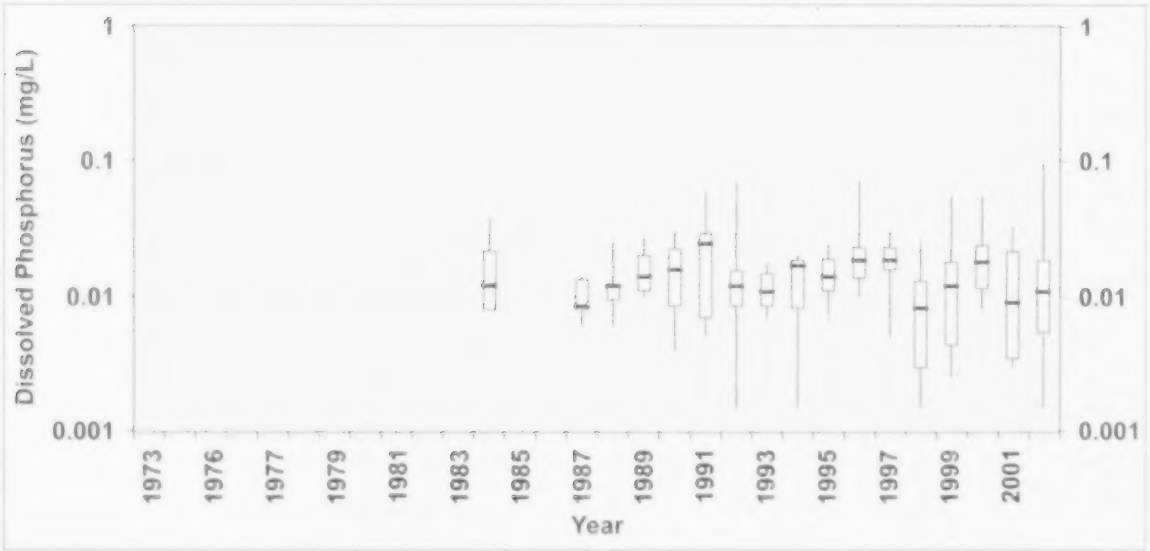


Figure 7 – Dissolved phosphorus at Old Fort

- Under the APF (Recommendation 1.1) governments, in collaboration with the agriculture sector and other stakeholders, have indicated that nutrients are among the priority challenges for further consideration in reducing environmental risks associated with agricultural activities.

NREI Legacy

Through increased efforts in monitoring (by AENV) and research conducted under the NREI significant progress was made in further understanding nutrient/productivity relationships in the Athabasca, Wapiti and Smoky river basins. Over the 5 past years, average total phosphorus loadings from pulp mills located on these systems has shown an increasing trend, while total nitrogen loadings have been variable and show no obvious temporal trend. Nutrient loadings from municipalities such as Grande Prairie and Jasper have declined as a result of improved treatment facilities. Another large and growing municipality, Fort McMurray, will be submitting engineering proposals to upgrade its system to tertiary treatment level. Pulp mill approvals in Alberta have now required the mills to conduct studies into ways to reduce their industrial wastewater pollutants, including nutrients, and Alberta Environment has continued to work with the mills in evaluating various options for nutrient control. Cumulative efforts by the NREI have resulted in an improved ability to establish reach-specific nutrient guidelines and will aid in the development of improved integrated nutrient management strategies for these systems.

NRBS RECOMMENDATION 1.4 (1996)

For other wastes;

a. *The objective be achieved within a reasonable period of time for other wastes, to eliminate or substantially reduce their discharge to the northern rivers.*
b. *An open, credible process be employed to develop a plan for achieving waste reduction or elimination.*

Governments' response to the recommendation (1997)

The governments agree that other wastes should be restricted, with a view to reduction or eventual elimination of their discharge to rivers. Canada and Alberta have been pursuing this goal by placing high priority on the reduction of other wastes discharged from pulp mills. These wastes affect colour, odour and other aesthetic characteristics, and have been shown to negatively impact the use of receiving waters. For example, the older pulp mills (Weldwood and Weyerhaeuser) are presently on a compliance schedule to reduce the amount of colour in their effluents.

Continuing technological developments will allow further reductions in waste discharges from other industrial sectors. For example, technology is being developed in the oil sands industry that promises to reduce and eventually eliminate the existing large tailings ponds, and reduce existing discharges from plant operations. These reductions are also handled under the Alberta *Environmental Protection and Enhancement Act* approvals process, which allows for full public disclosure and input. The federal government is committed to work cooperatively with the provinces and industry to continue to pursue such reductions and to achieve improved waste management overall.

Canada and Alberta will soon complete a province-wide evaluation of agricultural impacts on the aquatic environment. This work was conducted under the *Canada Alberta Environmentally Sustainable Agriculture Agreement*, which was a federal-provincial cost-shared program operating from 1992 to 1997. The program has yielded substantial information which can be used in the future to minimize water pollution from agricultural non-point sources. A successor program, called the *Alberta Environmentally Sustainable Agriculture Program*, will ensure that research continues on this topic.

NREI Progress Report 1 (1999)

- Discharges of other types of wastes to the northern rivers continue to be reduced through pollution prevention practices and technological upgrades at industrial and municipal treatment facilities (Recommendation 1.1).
- In 1996, the regulation of all waste management facilities, including those owned and operated by waste management companies, municipalities, and regional authorities, was transferred from the *Public Health Act* to the *Environmental Protection and Enhancement Act* and became the responsibility of Alberta Environment.
- The *Environmental Protection and Enhancement Act* approval for Weyerhaeuser Canada requires that they reduce "colour" in effluent discharged to the Wapiti River.
- The EPEA approval issued to Weldwood and Daishowa-Marubeni International Ltd in 1998 required a reduction in colour and chlorinated organics in their effluents.
- The Alberta Pacific mill already has stringent limits on its discharge and the remaining pulp mills will be reviewed when they renew their EPEA approvals.
- The *Alberta Environmentally Sustainable Agriculture* (AESA) *Program*, introduced in 1997, promotes the development and adoption of management practices and technologies that make the agricultural production and processing industries more environmentally sustainable. AESA has included streams within the northern basins as part of a long-term provincial monitoring network of water quality in relation to trends in agriculture.
- Alberta Agriculture, Food and Rural Development (AAFRD) has adopted water quality as a departmental performance indicator with a goal of maintain or improving the water quality in agricultural watersheds, including those within the northern rivers basin.
- "*Measuring Up*", the annual report from the Government of Alberta, includes water quality indices calculated for key river locations throughout the province.

NREI Progress Report 2 (2001)

- The Alberta government continues to report on the water quality performance measure for Alberta rivers in *Measuring Up*, using an enhanced Water Quality Index. The new index, introduced in 2000, gives more information for the following variable groups: nutrients; indicator bacteria; pesticides; and metals, thereby allowing trends in other wastes to be tracked. Water quality at the four index sites in northern Alberta have been ranked as "good" since the index calculations began several years ago. (see *Alberta Surface Water Quality Index - '01/02* page 24.)
- Additional process improvements are scheduled for Weyerhaeuser's Grande Prairie pulp mill during 2001 and 2002. New technology, called oxygen delignification, will be implemented to reduce the colour loadings to the Wapiti River by 50%.
- The Alberta *Environmental Protection and Enhancement Act* requires oil sands operators to reclaim disturbed land to an equivalent capability that will support identified land uses on the reclaimed area.
- The *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (March 2000) provides an approach for the development of wetlands on reclaimed landscapes in the oil sands region. These guidelines were developed by the *Oil Sands Wetlands Working Group*, which had representation from government, industry, consulting, university and aboriginal communities. The guideline presents an approach to wetland reclamation in terms of planning and design; development and management; performance assessment; and reclamation certification. This approach will allow the establishment of ecologically viable wetlands in landscapes impacted by oil sands mining.
- Selenium concentrations in tributary streams in the upper McLeod River and Smoky River systems exceeded water quality guidelines for the protection of freshwater aquatic life. A *Selenium Working Group*, which includes representatives from the coal industry, Alberta Environment, the Energy and

Alberta Surface Water Quality Index - '01/'02

	Previous years 96/97	97/98	98/99	99/00	00/01	Reporting year 01/02	Comments
SMOKY/PEACE RIVERS							
at Watino	84	83	91	90	93	94	Conditions are ranked as excellent at both sites. Index values have improved not meet guidelines. The index value has declined slightly at Ft. Vermilion this period, primarily due to some high spring nutrient concentrations associated with high suspended solids concentrations.
at Ft Vermilion	86	89	94	86	93	88	
ATHABASCA RIVER							
at Athabasca	91	92	90	91	97	99	Conditions are ranked as excellent at both sites. Index values have improved slightly at Athabasca and Old Fort, perhaps reflecting a general decrease in runoff and lower suspended solids concentrations, associated with drier conditions.
at Old Fort	90	90	95	91	94	97	

Water Quality Category Descriptions for the Alberta Surface Water Quality Index

96 - 100	Guidelines almost always met; "Best" Quality (Excellent)
81 - 95	Guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal (Good)
66 - 80	Guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels (Fair)
46 - 65	Guidelines often exceeded, sometimes by large amounts; quality is threatened; often departing from desirable levels (Marginal)
0 - 45	Guidelines almost always exceeded by large amounts; quality is significantly impaired and is well below desirable levels; "Worst" Quality (Poor)

Supplemental Information - 2001/02
Alberta Surface Water Quality Sub-Index

	SMOKY/PEACE RIVERS		ATHABASCA RIVER	
	at Watino	at Ft Vermilion	at Athabasca	at Old Fort
Metals	95	89	97	100
Nutrients	90	67	100	88
Bacteria	100	96	100	100
Pesticides	93	100	100	100
Average	*94*	*88*	*99*	*97*

Utilities Board, and the Department of Fisheries and Oceans was formed in 1999. The overall objective of the working group is to produce a framework and approach for the evaluation and management of selenium at mountain-foothills mines and provide a forum for sharing information, and developing monitoring and research studies.

NREI Update (2003)

- Since 1990, Alberta Environment has set increasingly stringent limits on colour discharges from Weyerhaeuser, as shown on Figure 8. An oxygen delignification process was implemented in July 2002 and has reduced the actual colour loadings discharged to the Wapiti River. The process has an added benefit of reducing adsorbable Organic Halides (AOX) concentrations in the effluent.
- Millar Western Forest Products explored numerous heat reduction technologies since 1994 before installing a fourth heat exchanger in 1999 and a cooling pond in 2002. Both unit operations have been successful at removing heat load from the wastewater stream without impacting treatment performance.
- The AESA Stream Survey is a long-term monitoring program designed to track water quality in several streams in agricultural areas across Alberta, seven of which are located in the northern river basins. The AESA Stream Survey is operated by: Alberta Agriculture; Alberta

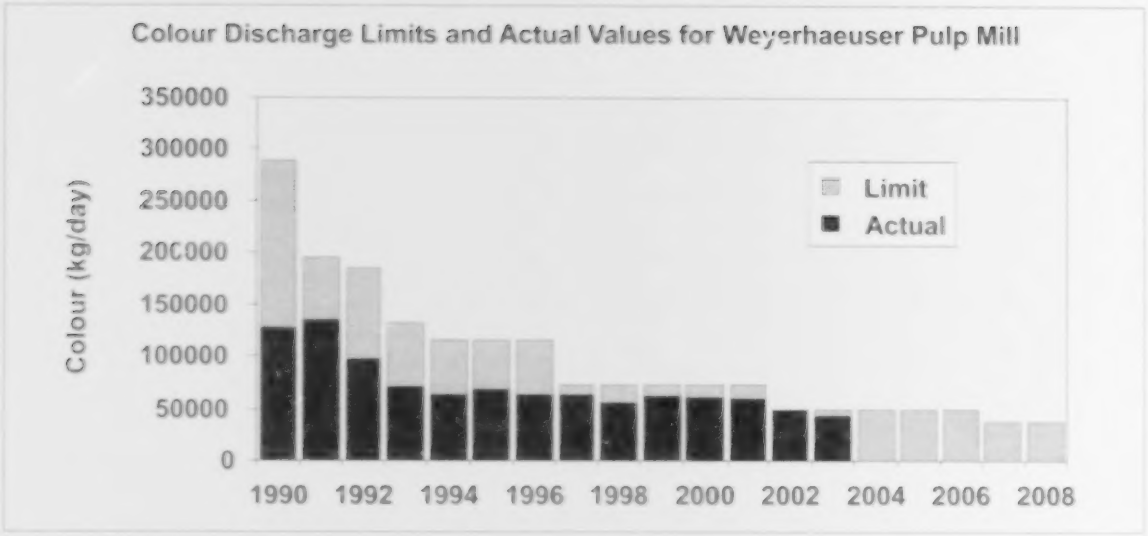


Figure 8

Environment; Alberta Health and Wellness; and PFRA. Program results are reported annually. Further details are available at: http://www1.agric.gov.ab.ca/app21/rtw/selsubj.jsp

- *Operation Clean Farm* was launched in the Peace River Region of Alberta in 2002, to assist farmers in the disposal of obsolete or unused pesticides. Approximately 22 tonnes of unwanted pesticides were collected from farmers in the first year. Funding for this initiative was provided by Crop Life Canada and Agriculture and Agri-Foods Canada's 'Canadian Adaptation and Rural Development Fund'.
- The Trace Metal and Air Contaminants Working Group of CEMA was established in 2000 and was tasked with developing management recommendations related to the air emissions of trace metals and other air contaminants in the region. A report entitled *"Review and Assessment of the Deposition and Potential Bioaccumulation of Trace Metals"* was completed in 2001. The report compares receptor exposure to health benchmarks and environmental guidelines for five trace metals. Further detail is available at: http://www.cemaonline.ca/
- Various selenium-related studies at three coal mines in west-central Alberta have been completed or are ongoing. Results of fish collections have shown elevated selenium in different species taken from sites downstream of mines, compared to upstream sites. Laboratory fish bioassays have shown increased levels of deformities in larval rainbow trout compared to brook trout, which appear to be less sensitive to selenium. The results of other studies on the levels and fate of selenium in aquatic food webs are currently being compiled and interpreted for the Selenium Working Group. Potential treatment options for elevated selenium in mine drainage waters will be investigated in 2003-04.

NREI Legacy

Technological advances by industry have contributed to an overall reduction of wastes discharged into the northern rivers basin. Actions have also been taken to minimize the potential impacts of wastes associated with land management practices, such as seen with the oil sands sector or in agriculture. In Alberta, the *Environmental Protection and Enhancement Act* will continue to be a major vehicle for regulating waste management by municipalities, regional authorities and waste management companies. As part of the approval process many companies are being asked to implement the most current and up-to-date technology in an effort to reduce the impacts of waste discharges. The federal government will continue to work with Alberta and other provinces to reduce waste discharge into the aquatic ecosystems and in supporting the implementation of waste management technologies.

NRBS RECOMMENDATION 1.5 (1996)

Regarding international agreements;

a. *The Government of Canada should vigorously pursue the development of international agreements, treaties or protocols consistent with the elimination or reduction of the use, generation or discharge of airborne pollutants.*

Governments' response to the recommendation (1997)

Canada is committed to addressing the transboundary movement of hazardous air pollutants and is involved in the management of chemicals through the 1991 *Canada–United States Air Quality Agreement*. Canada is also a participant in the *Partnership for Pollution Prevention* developed by the Organization of American States to advance continental action to reduce the atmospheric transport and deposition of lead and pesticides.

Through the United Nations Economic Commission for Europe's *Convention on Long-Range Transboundary Air Pollution*, Canada works towards the development of new protocols on persistent organic pollutants and heavy metals. The global management of persistent organic pollutants is being pursued through the *United Nations Environmental Program*.

Canada and Alberta are involved internationally in the sound management of chemicals as partners in the *North American Agreement on Environmental Cooperation* under the *North American Free Trade Agreement*.

NREI Progress Report 1 (1999)

- Canada continues to address transboundary air pollutants through a commitment to the 1991 *Canada-US Air Quality Agreement* and the *North American Agreement on Environmental Cooperation*.
- Hazardous air pollutants are being managed globally through the *United Nations Environmental Program (UNEP)*, of which Canada is a participant.
- Canada has been actively working toward the development of an international convention on persistent organic pollutants, and hosted the first negotiating meeting to draft the Convention in the summer of 1998.
- Canada is a member of the circumpolar "Arctic Council" which among other issues, is addressing concerns over the long-range transport of atmospheric pollutants as part of the *Arctic Environmental Protection Strategy*.
- The Northern Contaminants Program, administered by Indian and Northern Affairs Canada, is studying the effects of airborne chemical pollutants (including mercury). The results from this program are part of Canada's contribution to the international *Arctic Monitoring and Assessment Program*, a component of the *Arctic Environmental Protection Strategy*.

NREI Progress Report 2 (2001)

- The *Protocol to Abate Acidification, Eutrophication and Ground-level Ozone* (AEGLO) was signed in 1999 by Canada, along with 25 other countries in Gothenburg, Sweden during a meeting of the United Nations Economic Commission for Europe. This event also marked the 20th anniversary of the *Convention on Long-Range Transboundary Air Pollution* (LRTAP). Within the AEGLO *Protocol*, there are provisions for setting goals to reduce transboundary emissions of air pollutants that contribute to acid rain and ground-level ozone, two of Canada's priority air issues.
- In December 2000, Canada and the United States signed an Ozone Annex to the 1991 *Air Quality Agreement*, which involves commitments from both countries to reduce nitrogen oxides and volatile organic compound emissions that cause ground-level ozone to form.
- A number of large scale international actions are underway to address mercury emissions:

- an *Action Plan for Mercury Reduction* is being developed through the NAFTA North American Commission for Environmental Cooperation;
- a *Heavy Metals Protocol* to control releases of heavy metals, including mercury, in Europe and North America, has been completed and is being implemented; and
- the Eastern Canadian Premiers, in cooperation with New England Governors, have endorsed an action plan calling for substantial regional reductions in air emissions of mercury.

- In May 2001, 127 countries, including Canada, formally adopted a global treaty – the *United Nations Convention on Persistent Organic Pollutants* – banning 12 highly toxic chemicals. These 12, widely known as "the dirty dozen", include PCBs, dioxins and furans, DDT and other pesticides used in industry or created by improper waste disposal. Most POPs have been banned or restricted in Canada for years, but are still present due to long-range atmosphere transport from foreign sources.

NREI Update (2003)

- In December 2002, Canada ratified the *Kyoto Protocol*, an international agreement under the *United Nations Framework Convention on Climate Change* that establishes binding targets for reducing emissions of greenhouse gases. For more information go to: http://www.ec.gc.ca/climate/kyoto.htm
- In October, 2002, the Alberta government released its *Climate Change Action Plan* to address this issue. Implementation of the plan is expected to reduce emissions intensity in the province by 50 percent from 1990 levels, equivalent to a 60-million-tonne reduction in greenhouse gas emissions below the "business-as-usual" scenario. Among other strategies, the plan also supports national and regional research into adaptation to a warmer climate, which could benefit future research efforts related to the northern rivers' watersheds. For more information go to: http://www3.gov.ab.ca/env/climate/actionplan/docs/takingaction.pdf

NREI Legacy

Canada has shown a strong commitment to the reduction and elimination of hazardous atmospheric pollution as evidenced by its involvement and support of several international initiatives. The Canadian Council of Ministers of the Environment has adopted a strategy that will accelerate the phase-out of CFCs (chlorofluorocarbons) and halons, and dispose of surplus stocks. These actions demonstrate global leadership on behalf of Canada and the provinces. Canada will continue to be proactive in the reduction and elimination of airborne pollutants, through its involvement and participation in a variety of international agreements.

NRBS RECOMMENDATION 1.6 (1996)

And with respect to performance evaluation;

a. *The Ministers and their governments make a report to the public in five years (after this Study) on the progress achieved in implementing these recommendations.*

Governments' response to the recommendation (1997)

The federal and provincial governments regularly report on the state of the aquatic environment and pollution control effectiveness by means of interpretive technical reports, annual reports, performance measures, State-of-the-Environment Reports, and public meetings. These communication mechanisms will be continued and will cover actions taken in response to the NRBS recommendations. The task of addressing progress on the NRBS recommendations will also be referred to the Board to be constituted under the *Mackenzie River Basin Transboundary Waters Master Agreement* (Recommendation 23).

NREI Legacy

This Report provides a summary of activities and actions taken to address the recommendations provided to the Governments of Canada, Alberta and the Northwest Territories in the final report of the Northern Rivers Basin Study (NRBS). There is also a series of technical reports produced through the course of the NREI, all of which contribute to addressing one or more of the NRBS recommendations.

In addition to these reports a NREI *Synthesis Report* has also been prepared. This report provides an overview of the science that has been conducted as part of the NREI, but also incorporates aspects of various other initiatives that have been underway within the northern river basin since the conclusion of the NRBS. In addition to these reports the Mackenzie River Basin Board has prepared a *State of the Aquatic Ecosystem Report* for the entire Mackenzie River Basin, including the northern river basins of Alberta and NWT (Recommendation 21). This report was released in 2004.

NRBS RECOMMENDATION 2.1 (1996)

The Government of Alberta and Canada initiate and complete the necessary studies to determine the winter dissolved oxygen requirement for fish and other aquatic species as per the CCME Guidelines Protocol, *and subsequently assess the oxygen requirements for the organisms in the various reaches of the northern rivers.*

Governments' response to the recommendation (1997)

Canada and Alberta have committed to develop a joint three-year research plan to further assess the dissolved oxygen requirements of aquatic biota, and initiated preliminary studies in March 1997 on this issue. In the Athabasca River, benthic invertebrates at the location of lowest dissolved oxygen levels were monitored to gather direct information on the biological effects of winter dissolved oxygen conditions.

NREI Progress Report 1 (1999)

- Environment Canada, in cooperation with Alberta Environment, has initiated a three year study as part of the Northern Rivers Ecosystem Initiative to investigate dissolved oxygen (DO) requirements of the aquatic biota in the Smoky, Wapiti and Athabasca River systems.

NREI Progress Report 2 (2001)

- Findings from a NREI dissolved oxygen research project conducted on the Wapiti River, with assistance from Alberta Sustainable Resource Development, indicate that dissolved oxygen levels measured in the water column during winter months are not an accurate indicator of DO levels in the river bottom substrate where fish eggs may be incubating.
- Results also suggest that the DO guidelines adopted by the Canadian Council of Ministers of the Environment, which assumes that the dissolved oxygen differential between the surface water and the **pore water** (in the river substrate) is not more than 3 mg/L, may not be valid.

Pore water is the water found in the interstitial spaces within the substrate of the bed of the river.

- A review of existing documentation of fish spawning within the main-stem of the upper Athabasca River (*An Assessment of Fish Spawning Activities in the Main-Stem Athabasca River From the Town of Whitecourt, Upstream to the Jasper National Park Boundary: A Literature Review*) was completed by Alberta Environment in 2000. The report concluded that inadequate data were available to accurately portray the extent of fish spawning within this section of the Athabasca River.

NREI Update (2003)

- Results of the NREI study conducted by Environment Canada confirm that pore water DO concentrations measured during the winter on the Wapiti River are highly variable, whether in areas untouched by major development or in those reaches receiving effluents. Pore water DO did not display a consistent relationship with water column DO concentrations in either circumstance.

"Dissolved oxygen relationships of water column and pore water habitat: Implications for guideline improvements" (Culp *et al.*, 2004).

- The 3 mg/L differential between water column and pore water DO, as assumed by the CCME DO guideline, is not valid for this river.

Guideline: numerical concentration limit, or narrative statement, recommended to protect aquatic life.
Objective: a numerical concentration limit or narrative statement that has been established to support and protect the designated uses of water at a specified site.

- Alberta Environment has monitored benthic invertebrates in relation to dissolved oxygen (DO) conditions in the Athabasca River at Grand Rapids. This location allows an evaluation of the zoobenthic community under conditions of low winter DO (upstream) and near-saturation levels (downstream). A report summarizing the results of four winters of sampling has been prepared. Differences were found in the composition and abundance of invertebrates upstream and downstream of Grand Rapids on the Athabasca River for all four years. Results indicate that sustained winter DO concentrations below the 6.5 mg/L chronic guideline can adversely affect invertebrates in the Athabasca River.
- Near real-time monitoring of DO is conducted by Alberta Environment during the winter at Grand Rapids and other key site on the Athabasca River.

NREI Legacy

This research provides preliminary information on the physical relationships and assumptions concerning DO dynamics in northern river ecosystems. The findings introduce uncertainty into the usefulness of water column DO alone as an indicator for assessing risk in northern rivers where pore water habitats are important. Future DO objective development may need to consider site-specific conditions (e.g., substrate type, location of spawning areas, flow, effluent inputs) and specific biotic requirements to ensure adequate protection. Further information about water quality guidelines as developed by the Canadian Council of the Ministers of the Environment can be found at: http://www.ccme.ca/initiatives/water.html

NRBS RECOMMENDATION 2.2 (1996)

Alberta adopts the CCME Dissolved Oxygen Guideline *of 6.5 mg/L as an overall provincial approach in making decisions on future development proposals.*

Governments' response to the recommendation (1997)

Alberta accepts this recommendation and is adopting the 6.5 mg/L guideline province-wide. It is noted that winter dissolved oxygen concentrations in the Athabasca River have met the existing Canadian Council of Ministers of the Environment guideline of 6.5 mg/L throughout this decade. The federal government also applies this guideline for use in the National Parks and the Northwest Territories.

NREI Legacy

Alberta published new dissolved oxygen guidelines in August 1997, which included the chronic value of 6.5 mg/L. Further information is available in the document entitled *Surface Water Quality Guidelines for Use in Alberta*, published in November, 1999. The document is available on the internet at: http://www.gov.ab.ca/env/protenf/publications/SurfWtrQual-Nov99.pdf

Guideline development is an ongoing process and Alberta is committed to the review of current scientific research in its effort to improve the protection of aquatic ecosystems. As such, NREI research results relevant to DO guidelines (Recommendation 2.1) will be integrated into future guideline assessments.

Alberta Dissolved Oxygen Guideline

Chronic (7-day mean): 6.5 mg/L
Acute (1 day minimum): 5 mg/L

The chronic guideline is increased to 8.3 mg/L from mid-May to the end of June to protect emergence of mayfly species into adults.

The chronic guideline is increased to 9.5 mg/L for those areas and times when embryonic and larval stages of some salmonids (from spawning to 30 days after hatching) develop within gravel beds.

NRBS RECOMMENDATION 2.3 (1996)

Throughout the basin, nutrient and biological oxygen demand monitoring be improved, especially for municipal sewage treatment facilities and some pulp mills. Standards for Quality Assurance/Quality Control requirements be enhanced for existing and future effluent licences and permits. These data be logged in a central database and linked to provincial water quality data.

Governments' response to the recommendation (1997)

The governments agree that monitoring, quality control, and data management are very important.

A large amount of performance data is available for municipal and pulp mill effluent treatment systems, so that governments now have a good understanding of the expected levels of biochemical oxygen demand and nutrients in these effluents. Alberta will examine these data regularly as nutrient management strategies are developed for the northern rivers and will improve effluent monitoring as required. Nutrient and biochemical oxygen demand monitoring in the northern river mainstems will also receive regular reviews and upgrades (Recommendation 11).

A new data management system (ENVIRODAT) is being implemented by both Canada and Alberta. It will store effluent and surface water quality data together, thereby improving data access and sharing among all users. Ready access to stored quality assurance/quality control data is a feature of ENVIRODAT.

NREI Progress Report 1 (1999)

- Environment Canada has a policy that requires accreditation, and the *Canadian Environmental Protection Act* has a section that allows Environment Canada to specify the use of accredited facilities.
- Alberta has initiated the development of an *Analytical Data Quality Assurance Policy* that will ensure data reliability through the accreditation of labs and analytical procedures.
- Alberta Environment has developed a new computerized water quality data system that currently stores inorganic and organic chemical data as well as simple biotic measures.
- Requirements of the federal *Environmental Effects Monitoring Program* have resulted in increased monitoring of in-stream effects of nutrients discharged by pulp mills.
- Water quality monitoring of effluents will be increased for communities that upgrade their systems to a "tertiary treatment" level.

NREI Progress Report 2 (2001)

- In July 2000, the Policy Secretariat of Alberta Environment released the draft *Laboratory Data Quality Assurance Policy* for stakeholder review.
- Information on industrial wastewater releases are reported to the province and entered into a central database called the Environmental Management System. However, information on municipal wastewater releases is currently maintained by municipalities.
- All municipal and industrial monitoring data collected by Alberta Environment are entered into the Environmental Management System.
- Alberta Environment is preparing an *Industrial Monitoring and Reporting Directive* which will outline the acceptable practices and reporting formats for air and wastewater monitoring requirements, as stipulated in approvals issued under the *Environmental Protection and Enhancement Act*.

NREI Update (2003)

- In February 2002 Alberta Environment published the *Laboratory Data Quality Assurance Policy*. This policy document sets out the mechanism by which Alberta ensures that analytical data vital to environmental management and regulatory assurance are accurate and reliable. The policy requires laboratories to be accredited by the Standards Council of Canada for the analysis of environmental parameters considered essential to the Departments of Environment and Sustainable Resource Development. This policy stipulates that as on November 1, 2003 all approval holders must use an accredited lab. Further information can be found at: http://www3.gov.ab.ca/env/protenf/standards/labdata.html
- The Environmental Management System (EMS) is being enhanced to enable electronic reporting of both municipal and industrial effluent discharges. This enhancement is taking place under the terms of a partnership between Saskatchewan Environment Resource Management and Alberta Environment that was initiated in April 2003. Under the terms of this agreement, Alberta Environment provided the existing Environmental Management System (EMS) software to Saskatchewan Environment. In return, Saskatchewan Environment agreed to develop a "Treated Industrial and Municipal Effluent" component, which Alberta Environment will then customize for its use. Alberta Environment anticipates full implementation by March 31, 2005.

NREI Legacy

Governments remain committed to the inspection and enforcement of activities associated with the protection of water quality and water quantity in the northern river basin (Recommendation 6.0). Monitoring requirements, along with the quality control and quality assurance protocols, are critical cornerstones for assessing the performance of municipal and pulp mill effluent treatment systems. Policies requiring the use of accredited labs for the analysis of environmental samples will provide improved capability for comparing treatment systems and for reviewing long-term performance.

NRBS RECOMMENDATION 2.4 (1996)

Phosphorus concentrations in pulp mill effluents be reduced to minimal levels. Alberta require pulp mills to monitor and assess their operations to ensure that phosphorus additions are not in excess of what is needed to minimize BOD of effluent.

Governments' response to the recommendation (1997)

Alberta is actively seeking nutrient reductions through the pollution prevention and minimization initiatives stipulated in pulp mill approvals under the *Environmental Protection and Enhancement Act*. The objective is to ensure that mills do not use any more phosphorus than is required to optimize the performance of their wastewater treatment systems (see also Recommendation 1.3).

NREI Progress Report 1 (1999)

- Nutrients such as phosphorus are added to pulp mill wastewater treatment systems to optimize microbial breakdown of organic wastes and to reduce the toxicity of the wastewater. The goal is to reduce the Biochemical Oxygen Demand (BOD) of the wastewater discharged and thereby maintain adequate dissolved oxygen levels in the rivers.
- Alberta Environment monitors winter dissolved oxygen concentrations in the Wapiti and Athabasca rivers on a

continuous basis to ensure that water quality protection strategies continue to be effective.

- To ensure the optimum balance between nutrient addition and adequate dissolved oxygen levels, Alberta Environment has requested the development of nutrient minimization plans in many pulp mill-operating approvals under the *Environmental Protection and Enhancement Act*.

NREI Progress Report 2 (2001)

- Alberta Environment continues to evaluate the implications of nutrient additions to wastewater treatment facilities.
- Alberta Environment's Strategy to minimize BOD discharges to protect winter dissolved oxygen conditions in the Athabasca River has been successful, with concentrations above Grande Rapids being consistently at or above the DO guideline of 6.5 mg/L (Recommendation 2.2).
- A basin-wide evaluation of phosphorus loadings in the northern river basins has been initiated under the NREI to achieve a better understanding of nutrient dynamics and to improve our management strategies for nutrients.

NREI Update (2003)

- Phosphorus loadings from pulp mills continue to increase (Recommendation 1.3).
- Research conducted by Environment Canada on nutrient-plant relationships in the northern rivers has provided the science necessary to support the development of reach-specific nutrient objectives, which in turn will allow more comprehensive assessments of the impacts of nutrient discharges from pulp mill wastewater systems (Recommendation 1.3).
- Winter dissolved oxygen conditions in the Athabasca River have been monitored on a continuous basis for the past 15 years. During this period DO concentrations have remained above guideline values each year, with the exception of winter 2003 at the station upstream of Grand Rapids (Table 1). Late winter stream flows were extremely low during 2003 and were accompanied by prolonged cold temperatures. Alberta Environment is re-evaluating pulp mill effluent standards and will consider the linkages between nutrient use, BOD in effluents, river DO and winter conditions.

NREI Legacy

Nutrients are added to the treatment of effluents to minimize the BOD loads discharged to northern rivers and thus help to sustain appropriate levels of dissolved oxygen in these systems. These wastewater management strategies have, for the most part, been successful as determined through Alberta Environment's monitoring of winter dissolved oxygen concentrations. However, it is also recognized that nutrients themselves can have a long-term fertilizing effect on the receiving rivers which may enhance the winter oxygen demand when river biomass decays. As well, some of the work done as part of the NREI has raised concerns over the validity of current DO Guidelines as they relate to the survival of zoobenthos within the substrate (Recommendation 2.1). Other work conducted as part of the NREI has provided a basis for the consideration of reach specific nutrient guidelines which will contribute to a more comprehensive assessment of nutrient discharges in effluents (Recommendation 1.3). Alberta Environment will continue to evaluate effluent standards in the context of balancing nutrient inputs with the management of BOD in effluents and will continue to assess new science as it becomes available.

Date of Absolute Minimum Hourly [DO] Each Winter	Minimum [DO] Concentration (mg/L)	Date Range	Minimum 7-Day Mean [DO] (mg/L)
March 1, 1989	6.89	March 1-7, 1989	7.06
March 24, 1990	8.15	March 20-26, 1990	9.19
February 8, 1991	7.75	February 3-9, 1991	8.19
February 24, 1992	9.44	February 14-20, 1992	9.62
February 5, 1993	6.42	February 4-10, 1993	6.58
March 5, 1994	6.70	March 1-7, 1994	6.84
February 22, 1995	7.26	February 20-26, 1995	7.38
February 24, 1996	7.95	February 19-25, 1996	7.99
January 21, 1997	8.77	January 20-26, 1997	8.94
February 13, 1998	9.56	February 10-16, 1998	9.62
February 18, 1999	7.41	February 13-19, 1999	7.49
February 24, 2000	7.99	February 23-29, 2000	8.11
February 25, 2001	8.62	February 22-28, 2001	8.75
February 7, 2002	6.43	February 5-11, 2002	6.51
February 28, 2003	5.65	Feb.26-March 4, 2003	5.75
Acute guideline (5.0 mg/L)		Chronic guideline (6.5 mg/L)	

Table 1 *- Minimum winter dissolved oxygen concentration [DO] in the Athabasca River upstream of Grand Rapids*

NRBS RECOMMENDATION 2.5 (1996)

Municipal sewage effluent may require tertiary treatment to reduce phosphorus additions at certain locations. The Board recognizes the significant cost implications but emphasizes the importance of reducing phosphorus inputs over the long-term. Particular attention is drawn to the Wapiti/Smoky system at Grande Prairie, and to the inadequately treated municipal sewage entering the upper Athabasca River from the town of Jasper in Jasper National Park.

Governments' response to the recommendation (1997)

The governments agree with the importance of reducing phosphorus discharges at certain locations within the northern river basins. Alberta will require the City of Grande Prairie to implement tertiary treatment for phosphorus reduction at its municipal sewage treatment plant (Recommendation 1.3).

Canada, in cooperation with the Jasper Town Committee, is currently designing a new sewage treatment plant for that community. Tertiary treatment for phosphorus has been agreed upon and the target date for completion of the plant is the winter of 1999.

Canada and Alberta will develop a joint research plan in the autumn of 1997 to further refine reach-specific water quality objectives used to regulate nutrient discharges in the Wapiti/Smoky and upper Athabasca river systems.

NREI Progress Report 1 (1999)

- Alberta Environment will require the implementation of biological nutrient removal technology to reduce phosphorus concentrations in Grande Prairie's municipal effluent.
- Heritage Canada is working to bring the waste water treatment for the town of Jasper up to the tertiary level.
- Environment Canada research under NREI will contribute to the development of reach-specific water quality objectives that will be used to regulate nutrient discharges in the Wapiti, Smoky and upper Athabasca rivers.

NREI Progress Report 2 (2001)

- Alberta Environment issued an approval renewal under the *Environmental Protection and Enhancement Act* for the City of Grande Prairie Wastewater Treatment Plant in November 1999 for the period of 1999-2009, which requires the implementation of Biological Nutrient Removal technology to reduce nitrogen and phosphorus concentrations in the municipal effluent.
- Construction of the new wastewater treatment plant for Jasper is scheduled to begin in the spring of 2001, with completion expected late 2002.

NREI Update (2003)

- The reduction of phosphorus in municipal wastewater has been achieved at Jasper, and initiated at Grande Prairie, through the implementation of biological nutrient removal technology (Recommendation 1.3).
- Tertiary treatment of municipal waste waters is also being planned for Ft. McMurray (Recommendation 1.3) which will result in further reductions in nutrients.

NREI Legacy

A new municipal wastewater treatment system for the community of Jasper is now in full operation. This system uses biological nutrient removal technology with UV disinfection. The City of Grande Prairie has also implemented the biological nutrient removal technology as part of a recent upgrade to its wastewater treatment plant. Future upgrades at Grande Prairie's wastewater treatment plant will include UV disinfection of effluents. The introduction of tertiary treatment of municipal wastewaters is a very positive step towards managing nutrient loading in the northern rivers basin. Through Alberta's *Environmental Protection and Enhancement Act* approvals process, consideration is being given to other communities with regard to implementing tertiary treatment.

The NREI has also contributed new knowledge which will contribute to the development of reach-specific nutrient guidelines (Recommendation 1.3). The recent study, centered on the upper Athabasca and Wapiti Rivers, was able to develop nutrient/algal relationships for the specific eco-regions within these basins. These models, therefore, can form the basis for setting reach-specific guidelines for phosphorus and nitrogen concentrations, with the goal of not exceeding a set endpoint as measured against reference benthic chlorophyll *a* concentrations.

NRBS RECOMMENDATION 3.1 (1996)

The federal, provincial and territorial governments increase their efforts in the smaller communities to educate facility owners regarding the need to properly operate the water treatment facilities including the use of the existing programs for operator training, certification and assistance.

Governments' response to the recommendation (1997)

The governments acknowledge that a concerted, ongoing effort is required to educate operators and maintain drinking water facilities in small communities. The governments will work together to maximize efficiency in this regard. Alberta will maintain its programs of communication, assistance, training, and certification for operators. As well, Alberta will continue to work with the Plant Operator's Association in the preparation of an operator's manual for small treatment systems.

Canada will provide assistance for First Nations to run training and certification programs. Canada will continue to assist First Nations with the monitoring of water quality and with advice on human health. The Government of the Northwest Territories will cooperate with associations such as the NWT Water and Wastewater Association to raise the standard and expertise for operator training and certification.

NREI Progress Report 1 (1999)

- Health Canada, Alberta Environment and Alberta Health and Wellness are working cooperatively to train water treatment plant operators and, where necessary, to upgrade water treatment plant systems in off-reserve communities in northern Alberta.
- Drinking water and wastewater facilities for First Nations' communities are either owned and operated by the community or managed in agreement with adjacent municipal governments. As an example, a series of individual agreements have been negotiated among INAC, First Nations and the Municipal District of Wood Buffalo to operate water treatment plants, monitor drinking water quality, and provide training for treatment plant operators in First Nation communities.
- In northwestern Alberta, INAC and the North Peace Tribal Council created a *"Circuit Rider" program* in 1997 to deliver on-site training to water treatment plant operators in First Nations communities to ensure that provincial standards are met.
- The Government of the Northwest Territories has contracted the NWT Water and Wastewater Association to deliver training programs to water treatment plant operators in northern communities.
- INAC district staff work with smaller communities relative to issues of water licensing and best practices for minimizing water-related health problems.

NREI Progress Report 2 (2001)

- Alberta Environment is working with Alberta Health and Wellness, in conjunction with the Provincial Health Laboratories and Regional Health Authorities, to formalize a response protocol to be implemented when bacteriological sample results exceed drinking water guidelines at waterworks systems approved by Alberta Environment.
- Alberta Environment is compiling statistics on all approved waterworks systems to calculate newly established performance measures. These measures include bacteriological quality for groundwater and bacteriological/chemical quality for surface water treatment plants.
- In March 2001, the First Nations (Alberta) Technical Services Advisory Group, Health Canada, and Indian and Northern Affairs Canada, hosted a workshop for persons involved with the provision of drinking water in Alberta First Nations communities.

NREI Update (2003)

- Health Canada and Indian and Northern Affairs Canada collaborated to implement the following initiatives in First Nations communities in the northern river basins:
  - The development of a *"National Protocol for Safe Drinking Water in First Nation Communities South of 60"*. This protocol uses a multi-barrier approach, which identifies roles and responsibilities of all those involved in the provision of safe drinking water. It also includes protocols for emergency response, incident reporting, and 'boil water' advisories.
  - The expansion of the *Circuit Rider Training Program*, which provides water treatment operator training to all First Nations communities in Alberta.
  - The provision of portable bacteriological and digital chlorine test kits for community-based bacteriological water quality monitoring.
  - The organization of water quality monitoring workshops in 2002 and 2003 to train, educate and update Community Health Representatives on new equipment, standard procedures for water sampling and testing, bacteriological water quality monitoring protocols, as well as other water quality issues.
  - The implementation of a 24 hour on-call system to deal with public health emergencies, including drinking water issues.
  - The increase in the rate of bacteriological and chemical testing on community water supplies in Alberta's First Nations communities from once a month to four times monthly.
  - The development of a web-based database for the management of First Nation water quality results and records.
- A cross-government committee, led by Alberta Environment, steered the development of a provincial Water Strategy - *Water for Life*. The intent was to consult with Albertans on all aspects of water, including a strategy to ensure that all Albertans have access to safe and secure supplies of drinking water.
- Provincial stakeholder committees, led by Alberta Environment, Alberta Health and Wellness, Regional Health Authorities, and Health Canada revised a *Communication and Action Protocol* for drinking water test results that do not meet bacteriological standards.
- The Provincial Laboratory of Public Health (Microbiology), collaborating with government agencies and drinking water system operators, commenced a process to convert to the "defined substrate methodology" for bacteriological testing (E.Coli) of drinking water.
- The Technical Advisory Committee on Safe Drinking Water also organised a multi-sectoral drinking water conference in October 2002, and commenced development of a comprehensive reference manual and protocol to deal with the presence of cyanobacterial (blue-green algal) toxins in drinking and recreational waters.
- A Technical Advisory Committee on Safe Drinking Water, led by Alberta Health and Wellness, Regional Health Authorities and Health Canada, developed an *Environmental Health Field Manual* for owners and operators of all private systems.
- Alberta Environment conducted a review of the *Water and Wastewater Operator Certification Program* to improve opportunities and requirements for formal training.

NREI Legacy

Although, small communities often have difficulty in securing trained personnel to ensure the safe operation of water treatment facilities, there has been an ongoing commitment by the governments to support improved education and training for operators. First Nations, in particular, have taken a very proactive role in ensuring that the appropriate level of training and testing is done to ensure safe drinking water in many of their communities. Education and awareness programs are also considering a broader perspective, extending from the quality of drinking water at the tap, to protecting the quality of source waters – a 'source-to-tap', multi-barrier approach.

NRBS RECOMMENDATION 3.2 (1996)

The federal, provincial and territorial governments ensure that there are adequate treatment facilities, equipment and operating standards for their constituents.

Governments' response to the recommendation (1997)

The governments agree with this recommendation and will work closely with local governments and First Nations to ensure this is always the case.

NREI Progress Report 1 (1999)

- Drinking water quality in Canada is measured in terms of compliance with the latest edition of the *Guidelines for Canadian Drinking Water Quality*.
- Health Canada, Alberta Environment and Alberta Health and Wellness are currently assessing all existing water systems in northern Alberta to determine where improvements are needed, and to address operator-training needs.
- In cooperation with First Nations and municipal governments, Indian and Northern Affairs Canada have strengthened its capital planning and allocation activities in Alberta.
    - Within the last several years, new drinking water and wastewater treatment facilities have been built at Chipewyan Prairie and Garden River.
    - The Mikesew Cree at Allison Bay on Lake Athabasca are cost-sharing the installation of drinking water and sewage systems with Indian and Northern Affairs Canada.

NREI Progress Report 2 (2001)

- In the January 2001 *Speech from the Throne*, Canada committed to developing stronger national guidelines for water quality by enhancing scientific research and continuing its collaboration with partners.
- The Canadian Water Network, announced in March 2001 and based at the University of Waterloo, will focus on six key research areas: Drinking Water and Health; Wastewater Management; Infrastructure; Groundwater and Sediment Protection; Water Resource Management; and Policy and Governance.
- Canada and Alberta signed the *Infrastructure Canada-Alberta Partnership Agreement* in October 2000. The program's first priority is "green" municipal infrastructure projects, which includes projects related to water and wastewater systems, water management, solid waste management and recycling. Under this agreement up to $513 million will be directed to rural and urban municipalities across Alberta, with equal contributions from the federal, provincial, and municipal governments.

NREI Update (2003)

- Health Canada and Indian and Northern Affairs Canada (INAC), have collaborated to complete the following initiatives for First Nation Communities:
    - risk assessments on all community water and wastewater systems;
    - public health assessments of high risk community water systems; and,
    - multi-stakeholder planning and approval processes resulting in many water treatment plants being upgraded or replaced in Alberta's First Nation communities.
- Alberta Environment is chairing a stakeholder committee to revise existing water treatment design and performance standards to provide increased safety and lower risk for drinking water consumers.
- In 2003 Alberta Environment initiated a major study as part of "*Water for Life*" to conduct source-to-tap facility assessments for almost 50 communities in the northern

river basins. This study will prioritize source, treatment, and operational issues to ensure provision of safe drinking water to consumers. Alberta Environment committed $750,000 for the first phase of the review, which was completed in December 2003. More information on this review can be found at: http://www.waterforlife.gov.ab.ca/html/review.html

NREI Legacy

Further to the commitment to education and training for water treatment plant operators (Recommendation 3.1), improvements to water treatment facilities, both in terms of upgrading with new technology and improved protocols for testing, has been supported by all levels of government. Resources announced through the *Infrastructure Canada-Alberta Partnership Agreement* will provide one means of achieving improvements to an aging water treatment and distribution system. The 'source-to-tap' facility assessments being conducted by Alberta Environment will also provide a means of addressing priority issues associated with supplying a safe and secure water supply to consumers. First Nations have already taken steps to improve training and education in many of their communities (Recommendation 3.1) and are also partnering with other levels of government in assessing the state of existing water and wastewater systems. Despite the positive efforts associated with improved education and facilities, continued vigilance at all levels of government is required to ensure a continued safe and reliable drinking water supply for the people of the northern rivers basin.

NRBS RECOMMENDATION 4 (1996)

The proposed Alberta Water Act make specific provision for the integration of water quantity and water quality planning and administration.

Governments' response to the recommendation (1997)

The governments concur with this recommendation. The new Alberta *Water Act* includes provisions that recognize the importance of integrating water quantity and water quality planning and administration, and therefore addresses this concern.

NREI Legacy

The Alberta *Water Act* came into force on January 1, 1999. *The Framework for Water Management Planning and the Strategy for the Protection of the Aquatic Environment*, requirements under the Act, have been completed and are available to guide planning activities. Details can be found at: http://www3.gov.ab.ca/env/water/legislation/Framework_Text_Only.pdf

NRBS RECOMMENDATION 5 (1996)

The Government of Alberta provide leadership in water management planning incorporating, as a first priority in the water management process, instream flow needs for ecological purposes in the northern rivers and their tributaries within the province.

Governments' response to the recommendation (1997)

Alberta commits to providing such leadership. The commitment is demonstrated in specific provisions of Alberta's new *Water Act* which call for the development of water management plans that incorporate aquatic environmental protection strategies. Instream flow needs for the protection of biological communities will be incorporated as a high priority in the planning.

NREI Legacy

Instream flow needs are identified as an integral component in the *Strategy for the Protection of the Aquatic Environment*, a provision of Alberta's *Water Act* (Recommendation 4) and are to be addressed as part of water management planning.

NRBS RECOMMENDATION 6 (1996)

Jurisdictions of the northern river basins strengthen and publicize inspection and enforcement activities with respect to protection of water quantity and quality.

Governments' response to the recommendation (1997)

The NRBS Board found that basin residents were not fully aware of the range of inspection and enforcement activities already being undertaken by governments. The governments agree that enforcement of environmental laws is very important. Under federal and provincial laws several enforcement tools are used to accomplish this including: tickets, enforcement orders, administrative penalties, prosecutions, and cancellation of approvals or certificates.

The governments endorse the publicizing of enforcement actions taken and note that both the federal and provincial governments publish annual reports on this topic. In the Northwest Territories the federal government makes inspection reports relating to water licenses available to the public on request. The three governments will develop improved mechanisms to inform the public.

NREI Progress Report 1 (1999)

- Canada and Alberta have agreements in place that ensure minimal duplication in the enforcement of federal and provincial environmental laws.
- The revised *Canadian Environmental Protection Act*, which was proclaimed in September 1999, strengthens the enforcement process for federal environmental officers.
- Reports, such as spill reports, the *National Pollutant Release Inventory* and the federal *Environmental Effects Monitoring Interpretive Report*, are all publicly available.
- The first comprehensive report related to the enforcement of Alberta's *Environmental Protection and*

Enhancements Act for the period of September 1, 1993 to December 31, 1995 was release in April 1996, with annual reports available since then.

- In May 1998 Alberta Environment created a Compliance Division which has the responsibility of tracking and reporting all compliance and enforcement initiatives undertaken within the department.
- Alberta Environment undertakes quality assurance and control activities relative to compulsory monitoring data supplied by industry.
- The NWT Water Board maintains a public registry that includes compliance reports submitted by Water Resources Officers from Indian and Northern Affairs Canada.

NREI Progress Report 2 (2001)

- Alberta Environment restructured its enforcement process, and has deployed personnel dedicated to enforcement activities into each of its six organizational regions.
- Alberta Environment has developed *Compliance Assurance Principles* that describe how the department will continue to use education, prevention, and enforcement to ensure that regulated parties comply with the legislation administered by Alberta Environment.
- Alberta Environment also reported on the number of compliance assessments (inspections, reviews and audits) and enforcement activities completed in 1999-2000 under legislation administered by Alberta Environment.

NREI Update (2003)

- *An Act to Amend the Canadian Environmental Assessment Act*, was given Royal Assent on June 11th, 2003 and was proclaimed into force October 30, 2003 (Recommendation 1.1). As part of this revision was the creation of the *Canadian Environmental Assessment Registry* (CEAR) which meets the mandatory requirement for a Public Registry under the Act. Access to the registry can be found at: http://www.ceaa.gc.ca/050/index_e.cfm
- Alberta Environment continues to publicize the number of compliance assessments (inspections, reviews and audits) and enforcement activities that are completed under the *Environmental Protection and Enhancement Act* and the *Water Act*. The province's *Compliance Assessment and Enforcement Initiatives Annual Reports* summarize activities undertaken by Alberta Environment to ensure approval holders and all Albertans clearly understand their environmental obligations.
- *Compliance Assurance Principles* and all *Compliance Assessment and Enforcement Activities Annual Reports* for the years 2000-2001 and 2001-2002 are posted on the Ministry's web site at: http://www3.gov.ab.ca/env/protenf/enforcement/index.html
  Quarterly reports up to June 2003 are also available at this site.
- Water use in the Northwest Territories is authorized through the NWT Water Board, the Gwich'in Land and Water Board (www.glwb.com), the Sahtu Land and Water Board (www.slwb.com), and the Mackenzie Valley Land and Water Board (www.mvlwb.com). Inspection and enforcement activities are carried out by Indian and Northern Affairs Canada (www.inac.gc.ca).

NREI Legacy

Governments continue to publicize inspection and enforcement actions. Governments believe that a combination of education, prevention, enforcement, and public awareness are important to the sustainability of the environment and the water resources of the northern rivers basin. The federal and provincial governments continue to publish annual reports and have taken added measures to make them more readily accessible through electronic media (i.e., internet).

NRBS RECOMMENDATION 7.1 (1996)

The governments of Canada, Alberta and British Columbia implement an action plan for reclamation of the Peace-Athabasca Delta, the plan to include provisions for environmental impact assessment and public consultation with delta residents and with those that might be affected downstream, such as at the Slave River Delta.

Governments' response to the recommendation (1997)

The governments agree to the long-term protection of the ecologically important deltas of the northern river basins. Furthermore, governments recognize their societal importance. NRBS studies identified several deficiencies in our understanding of the ecological effects of flow regulation and of hydrologic-climatic interrelationships.

Canada and Alberta, in concert with First Nations and BC Hydro, released the final report of the *Peace–Athabasca Delta Technical Studies* in March, 1997. Based on these results and those of the NRBS, Canada, Alberta, and BC Hydro in partnership have initiated a follow-up study to specifically assess the hydrological and climatic conditions in 1996 that resulted in two significant floods of the Delta. Based on the findings of all studies, Canada and Alberta will work with stakeholders to develop appropriate action plans for management and research which will include environmental evaluations and public consultation.

NREI Progress Report 1 (1999)

- NREI studies were initiated in response to the 1996 and 1997 flooding of the Delta.
- In 1998 and 1999, Ducks Unlimited, in partnership with BC Hydro and Environment Canada, undertook population surveys throughout the Peace-Athabasca Delta (PAD).

NREI Progress Report 2 (2001)

- Ecological effects of flow regulation and hydrologic-climatic interrelationships affecting the Peace-Athabasca Delta are being investigated as part of studies being conducted under the NREI by Environment Canada, with the assistance of Alberta Environment, BC Hydro, and various universities.

NREI Update (2003)

- In March 2000 the Wood Buffalo National Park (WBNP) hosted a meeting of the former PAD Technical Committee. The purpose of the meeting was to review a draft Ecosystem Management Plan for the PAD that had been prepared by Ducks Unlimited under contract to WBNP. Five jurisdictions were identified as having a responsibility for implementation of the plan and as such would be the signatories to the agreement including: Alberta (Alberta Environment), Athabasca Chipewyan First Nation, Fort Chipewyan Métis Association #125, Mikisew Cree Nation and Canada (Parks Canada). No agreement to implement the plan has been signed.
- NREI has completed a number of studies that provide additional scientific input in support of future discussions related to the adoption of an Ecosystem Management Plan for the PAD.

"Monitoring Delta Ecosystem Response to Water-Level Restoration" (Toyra and Pietroniro, 2004).

- A remote sensing approach, incorporating various forms of satellite imagery, was successfully used to monitor the spatial-temporal changes in water levels associated with the flooding of the Delta in 1996 and 1997.
- A detailed digital elevation model (DEM) created for the PAD was used to generate the time series of flood maps, which were the basis for assessing the extent and duration of flooding. This DEM will also be very useful for future development of

two-dimensional hydraulic flow models in the PAD.

- Vegetation patterns from 2001 were related to the flood maps and form the basis for future ecological assessments of the Delta, as well as providing a reference tool for past vegetation/habitat regimes.

"Modelling climate change impacts on water availability in the Peace-Athabasca Catchment and Delta" (Pietroniro *et al.*, 2004).

- Hydrological and hydraulic models were used to investigate the relative roles of climate variability and flow regulation on the northern rivers and in the Peace-Athabasca Delta.
- Historical temperature/precipitation data and climate change scenarios were used to develop hydrographs for existing and future stream flows for the Peace and Athabasca rivers.
- Evaluations of runoff characteristics derived by a comparison of estimated current and future climate scenarios points to earlier spring melt and higher winter flows. Increases in winter flows will contribute to total annual flow volumes. There is potential for diminshed flows during the summer months.
- Climate scenarios indicate that the main increases in annual runoff volume will likely occur in the higher elevations, including those in flows to the Williston Reservoir. Although subject to high variability in output, the future climate scenarios suggest that inflows to the Williston Reservoir may be higher during the winter and lower in the summer, which could potentially influence its operation.
- A winter severity sensitivity analysis was performed using a hydraulic model in the PAD, which indicated:
  - That milder winters (shorter ice seasons) would reduce the water levels in channels and major lakes of the Delta (Athabasca, Claire and Mamawi); longer winter seasons would increase water levels.
  - The winter severity effect is generally of a short duration in the channels, but the effect can extend over several months in the lakes.
  - Future climate change scenarios suggest that there will be milder winters and, as such, there would be a general decline in lake levels within the Delta as well as in the rivers draining into the PAD.

"Hydro-climatic impacts affecting the Peace-Athabasca-Slave catchment and deltas" (Prowse *et al.*, 2004).

- Water balance modeling of wetlands within the Peace-Athabasca Delta indicate that they could dry up in less then ten years under current climatic conditions unless re-flooding occurs. Future climate scenarios suggest that wetlands would dry out even more rapidly due, in part, to a longer open-water period and an increase in open-water evaporation.
- Lateral extension of the large Delta lakes and overbank flooding from delta channels remains an important mechanism for recharging Delta wetlands. A detailed evaluation of the open-water flooding regime helped to characterize this well known phenomenon within the Delta.
- An analysis of naturalized (i.e., unregulated) flows suggests that there has been a decrease in the volume and duration of flow reversals from the Peace River into the PAD since regulation of the Peace River (1972-1996). Although flooding of the perched basins is more likely to occur as a result of ice jam events (e.g., 1974), this analysis indicates that there may have been at least two occasions post-regulation (1972 & 1990) where open-water naturalized flows could have resulted in overbank flooding.
- Studies reaffirmed the importance of spring ice-jam flooding to the recharge of Delta wetlands and further quantified the hydro-climatic controlling factors. The study suggested, however, that future climate-change scenarios would result in a decline in the frequency of ice-jam flooding, largely due to a reduction in the alpine snow pack, although there is the possibility that mid-winter breakup events could develop.
- The importance of the alpine snow pack accumulation and melt to the 'triggering' flows that can generate ice jamming in the

vicinity of the PAD were investigated. The analysis confirmed a shift in precipitation patterns over the headwaters of the Peace and Smoky rivers during the mid-1970s and suggested a strong relationship with the Pacific/North American pattern and Southern Oscillation Index.

"An Investigation of Migrant Shorebird Use of the Peace Athabasca Delta, Alberta, 1999" (Beyersbergen, 2003).

- A synoptic survey focusing on PAD wetlands and their role in the provision of resting or staging habitat for migration of Arctic-nesting shorebirds was conducted in 1999. The study evaluated wetland habitats relative to the hydrologic changes associated with the flooding in 1996 and 1997 and concluded that:
  - The level of use by Arctic migrant shorebirds was lower than expected, compared to use of staging areas on the Canadian Prairies. Aerial observations, however, indicated that habitat was not a limiting factor for shorebird use.
  - Suitable shorebird habitat was abundant and widely distributed throughout the Delta in the spring, but new vegetation growth and summer flooding restricted some habitat during the fall.
  - Several key habitats, important to pre-migration staging for 'local' breeding shorebirds, were also identified. Continued monitoring of these sites would provide insight into long-term use by local populations.
  - The dynamic nature of the Delta and external factors along the continental migration corridor will influence annual migrant shorebird use of the area but, in the long term, it is likely that shorebirds will use the Delta wetlands when the need arises and habitat conditions are suitable.

"State of the Aquatic Environment: Peace Athabasca Delta, 2002" (Donald *et al.*, 2004).

  - The number of shorebirds observed during the surveys indicates that the PAD meets the requirements for a *Western Hemispheric Shorebird Reserve Network* site (Regional Category).
- A previous NRBS report *"Indicators of Ecosystem Integrity: Peace Athabasca Delta" (NRBS Report 107)* proposed a variety of environmental goals based on key ecosystem indicators. These indicators were also assessed during NREI:
  - Goal 1: Climate - generally not being met with regard to mean annual temperature and annual total precipitation indicators. Recent patterns of temperature and precipitation have been different than that of previous decades, generally demonstrating: warmer annual temperatures, wetter summers, but drier in other seasons.
  - Goal 2: Water Quality - ecosystem goals for water quality are not being met for some parameters (e.g., dissolved sulphate and total dissolved solids in the Athabasca River).
  - Goal 3: Water Level - water levels in Lake Claire, the ecosystem indicator lake, remain within historic levels, but annual water level fluctuations have been reduced.
  - Goal 4: Benthic Invertebrate Community - the benthic invertebrate ecosystem indicator, clam shrimp, was not present in the surveys conducted during 2000 and 2002 in Mamawi Lake.
  - Goal 5: Fish Community Structure - the indicator is catch from Mamawi and Clair lakes. This goal is being met, with long-term relative abundance of fish species remaining remarkably stable and constant over time.
  - Goal 6: Goldeye Abundance - the goal of sustained Goldeye abundance is being met with no statistical difference in mean catch-per-unit-effort from 1973-2002.
  - Goal 7: Walleye and Goldeye Fishery: The commercial catch limits identified for this goal are being met.

NREI Legacy

Considerable effort has gone into understanding of the ecological dynamics of the Peace-Athabasca Delta. Efforts in this regard began shortly after the completion of the W.A.C. Bennett Dam, and resulted in some adaptive measures (e.g., rock filled weirs). Additional ecological and hydrological studies were conducted as part of the NRBS and the PAD Technical Studies. Although several questions remained unanswered, a draft Ecosystem Management Plan for the PAD was tabled in 2000 at a meeting that included the five principal jurisdictions: Alberta (Alberta Environment), Athabasca Chipewyan First Nation, Fort Chipewyan Métis Association #125, Mikisew Cree Nation and Canada (Parks Canada). No agreement to implement the plan has been signed.

Studies during the NREI have provided additional information and building blocks that can be used for managing the PAD. Along with the studies related to the hydrology and climate of the Delta, NREI also supported efforts to better understand the ecological dynamics of the Delta as it relates to the hydrology. Monitoring techniques have been developed to support the management of the Delta and hydrologic-climate models have been designed that can assist in testing potential outcomes from various management scenarios. And, ecological indicators, which were established during the NRBS, have been re-evaluated and can be used over the long term to as a performance measure of the success of management decisions.

The governments continue to support the long-term protection of the ecologically important deltas of the northern river basins. The need for a Management Plan for the Peace-Athabasca Delta will be referred to the Mackenzie River Basin Board for consideration. As a requirement of the *Mackenzie River Basin Transboundary Waters Master Agreement*, each of the pairs of jurisdictions that share a common border in the Mackenzie River Basin will have to negotiate individual agreements that will address transboundary water resource management issues, which could include the Peace-Athabasca Delta.

NRBS RECOMMENDATION 7.2 (1996)

As a principle for any future negotiations on mitigation of the impacts of the Bennett Dam, that the dam's operating regime be modified to help rehabilitate the Peace-Athabasca Delta and the riparian and aquatic conditions of the Peace River system. Further, that economic considerations of power production from this industry should not take precedence over the environmental stability and natural ecosystem of the Peace River, Peace-Athabasca Delta, Slave River and Delta and the Mackenzie River system.

Governments' response to the recommendation (1997)

The governments agree that the operating regime of the Bennett Dam must consider downstream impacts. Alberta has been negotiating with British Columbia on water management issues in the Peace River for over a decade, particularly with regard to operation of the Bennett Dam. This has had some benefit in terms of mitigating impacts on the town of Peace River and on winter ice bridges along the river. More recently, there has been co-operation in operating the dam in such a way as to enhance spring flows in the Peace-Athabasca Delta with the hope of flooding the unique "perched" basins.

The governments will continue negotiations with the province of British Columbia to mitigate the effects of the Bennett Dam on downstream ecosystems. Any mitigation for the Peace-Athabasca Delta will require careful consideration of the results of all studies, as noted above for Recommendation 7.1.

NREI Legacy

In 1998, the *Mackenzie River Basin Transboundary Waters Master Agreement* was signed by Canada, Yukon, Northwest Territories, Saskatchewan, British Columbia and Alberta. This agreement commits the jurisdictions to negotiating **bilateral agreements**. Alberta and British Columbia have started their negotiations. Issues related to the Bennett Dam are being discussed.

Bilateral Agreements:
As a requirement of the *Mackenzie River Basin Transboundary Waters Master Agreement*, each of the pairs of jurisdictions that share a common border in the Mackenzie River Basin are negotiating individual side agreements that will address transboundary water resource management issues.

Although no specific management agreements are in place, the studies that have been conducted throughout the NREI relative to climatic variability, flow regulation and hydrology that trigger the flooding events in the northern rivers and deltas will contribute to future management plans.

NRBS RECOMMENDATION 8 (1996)

Formal arrangements be made to ensure that land use planning and water use planning are integrated as basin management planning throughout the northern river basins;

a. The effects on surface waters and the mainstem rivers of agriculture, forestry, oil and gas activities and other land clearing be reviewed on a continuing and comprehensive basis;

b. All aspects of land use activities be scrutinized including land clearing, road building, channelization, revegetation, use of fertilizers and biocides and waste disposal;

c. Attention be given to groundwater levels, flow patterns in tributary streams and the integrity of fish spawning areas; and

d. Compounding effects of potential climate change and of atmospheric sources of contaminants be considered as important elements of context.

Governments' response to the recommendation (1997)

The governments agree with these recommendations and note that such formal planning arrangements have now been set out in Alberta's recently passed *Water Act*. As noted in the response to recommendation 1.1, land use effects (as non-point source inputs), local atmospheric deposition, and long-range transport of air pollutants, are specifically acknowledged as important elements of aquatic ecosystem planning and protection.

Alberta is committed to integrating its natural resource management decision-making. This commitment is supported by the corporate structure of Alberta Environment which includes lands, forests, parks, fish, wildlife, water, air and water approvals, and pollution control enforcement. Canada conducts integrated planning as part of its strategy to manage Wood Buffalo and Jasper National Parks.

Further research is needed to fully understand the ecological effects of land use changes. Governments commit to work with industry and other stakeholders to identify priority research needs. In addition to the Northern Forest Research Centre in Edmonton and forestry research at the Alberta Research Council, Vegreville, Canada and Alberta are supporting the Foothills Model Forest and the Network Centre of Excellence in Sustainable Forest Management at the University of Alberta. Other research programs at the National Hydrology Research Institute, Saskatoon, and at the Forest Engineering Research Institute of Canada, Vancouver, are continuing forestry-related research in these basins. Alberta has commissioned the *Alberta Forest Conservation Strategy*, and has established a Forest Management Science Council to advise on the best management of forests. Recommendations have been received from these two initiatives and are under consideration.

NREI Progress Report 1 (1999)

- Alberta adopted a formal policy with regard to sustainable development entitled *Alberta's Commitment to Sustainable Resource and Environmental Management*.
- Acknowledging the significant interest in the development of Alberta's oil sands, a *Regional Sustainable Development Strategy* (RSDS) was implemented.

- The *Clean Air Strategic Alliance* (CASA) continued to coordinate the evaluation of issues related to environmental impacts on air quality. In 1999, CASA developed a human health and air quality monitoring framework for Alberta.
- As part of NREI, Environment Canada implemented a project to assess the relative contribution of atmospheric inputs of mercury to the aquatic ecosystem. This project was linked with the *Canadian Atmospheric Mercury Monitoring Network* (CAMNet), which was established in 1997.
- The Government of Alberta announced two initiatives in 1998 to deal with issues surrounding the expansion of intensive livestock operations:
  - A scientific evaluation entitled *The Assessment of Potential Environmental Effects of Livestock Expansions in Alberta*;
  - A detailed review of regulatory options for ensuring the environmental sustainability of intensive livestock operations.
- A number of policy/management activities related to the impacts of the forest industry were initiated within the northern river basins:
  - Alberta released a policy statement in 1998, the *Alberta Forest Legacy*, which built upon the *Alberta Forest Conservation Strategy*, to support an adaptive ecological management approach to forest management that encompasses both terrestrial and aquatic values.
  - Alberta Environment also released the *Interim Forest Management Planning Manual*, which supports incorporation of watershed and fisheries considerations into forest management planning.
  - An Alberta *Forest Biodiversity Monitoring Program* was implemented and has developed ecological indicators that will measure the success toward the goal of sustainable development in Alberta's forests.
- Forest research programs were identified:
  - The Network Centre of Excellence in Sustainable Forest Management (centred at the University of Alberta).
  - The *Terrestrial and Riparian Organisms, Lakes and Streams* (TROLS) program at the University of Alberta.
  - The *Northern Watershed Program* has been supported by Alberta Environment, Alberta Research Council, the forest industry, the energy industry and the Alberta Conservation Association.

NREI Progress Report 2 (2001)

- Alberta Environment, along with stakeholders, completed the *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area* (RSDS) framework design on July 31, 1999. The purpose of this framework is to manage the cumulative environmental effects of multiple developments in the Athabasca Oil Sands Area.
- The stakeholder group involved in the design of RSDS in the northern river basins has since become incorporated as a society, the Cumulative Environmental Management Association (CEMA). Working groups within CEMA have been instrumental in developing regional management objectives for key indicators:
  - The Sustainable Ecosystems Working Group, which includes the Biodiversity, Landscape and Wildlife and Fish working groups.

The mandate of *Regional Aquatic Monitoring Program* (RAMP) is to determine, evaluate and communicate the state of the aquatic environment in the Athabasca Oil Sands Region. RAMP is designed as a long-term monitoring program with sampling frequencies ranging from continuous or seasonal to once every few years. The sampling program includes surveys of water quality, sediment quality, benthic invertebrates, fish, wetlands, vegetation, climate and hydrology. The data collected through the program will be used to detect cumulative effects and regional trends, establish baseline conditions and verify predictions that were contained in the *Environmental Impact Assessments* (EIAs).

  - The Trace Metals and Air Contaminants Working Group and the NO_x/SO_x Management Working Group, both of which consider the effects of air emissions on ecosystems, including aquatic receptors.
  - The Water Working Group, which conducted a detailed analysis of surface water issues in the region and used it as a basis to recommend management objectives for aquatic biota.
- The *Regional Aquatic Monitoring Program* (RAMP) was initiated in 1997 by the oil industry to collectively carry out its aquatic survey and monitoring needs in the area. RAMP is a multi-stakeholder initiative with representation from industry, aboriginal groups, and federal and provincial governments.

NREI Update (2003)

- Alberta initiated the *Northern East Slopes Sustainable Resource and Environmental Management Strategy* in June 2000. The area consists of 7.7 million hectares and includes the headwaters of the Athabasca and Smoky rivers.
  - A regional steering group was formed to make planning recommendations, which balance economic, environmental and community values. The group completed its task in May 2003, and forwarded its recommendations to the Alberta Minister of Environment. The report is available at: http://www3.gov.ab.ca/env/regions/nes/strategy.html
- Alberta Environment and Alberta Sustainable Resource Development, through the *Regional Sustainable Development Strategy for the Athabasca Oil Sands* (RSDS), continue to work to improve the current environmental management system. This is being achieved in partnership with CEMA and through consultation with local stakeholders in the Regional Municipality of Wood Buffalo.
  - Participation in CEMA is a long-term commitment that was made by many industrial proponents during regulatory approval and public hearing processes.
  - CEMA, which is instrumental to the implementation phase of RSDS, has formed working groups to begin resolution of the RSDS 'Category A' themes, which include: sustainable ecosystems; cumulative impacts on wildlife; biodiversity; effects of trace air emissions on human health, wildlife and vegetation; and bio-accumulation of heavy metals; as well as surface water issues (water quality/quantity & fisheries).
  - This work includes developing consensus-based environmental thresholds, indicators, best management practices, and ongoing research and monitoring to avoid adverse cumulative effects on the region's environment during this period of unprecedented development.
  - The Trace Metals and Air Contaminants Working Group has compiled a list of airborne contaminants and has ranked these contaminants relative to their toxic potential to humans, odour potential and potential to bioaccumulate. The compilation of these data indicated that the oil sands industry is the primary source of contaminant emissions in the northern region. Approximately 1400 unique contaminants, emitted to the atmosphere from these anthropogenic sources, were identified. A small fraction of these will be selected for further assessment.
  - Further information on CEMA can also be found at its website: http://www.cemaonline.ca/
- Alberta Environment is an active participant in the Wood Buffalo Environmental Association (WBEA), which conducts air quality, ecosystem and human health effects monitoring in the Regional Municipality of Wood Buffalo. The Association also facilitates dialogue among its members and others in the region to be sensitive and responsive to the environment in their planning, decision making and operations. Further information about this association is available at: http://www.wbea.org/html/about.html

"Atmospheric Contribution to Mercury Loading in the Northern Aquatic Systems" (Wiens *et al.*, 2004).

- The levels of total gaseous mercury (TGM) measured at Fort Chipewyan during 2000 and 2001 were lower than background levels at other Canadian sites. These low atmospheric levels of mercury suggest that dry deposition in northern Alberta would be at or below "global background deposition" rates.
- This preliminary work further indicates that observed differences in hourly TGM levels could be attributed to the origin and trajectories of air masses over northern Alberta.
    - Air masses from the south occasionally displayed higher levels; air masses from northern zones tended to display lower TGM levels.
    - Overall, the data suggest that nearby industrial sources are having a very modest effect on mercury concentrations in the Fort Chipewyan area.

"Development of a cumulative effects assessment framework for aquatic ecosystems: the Northern Rivers Ecosystem Initiative demonstration project" (Dube *et al.*, 2004).

- A Cumulative Effects Assessment (CEA) framework was developed by Environment Canada, as part of the NREI, and provides a mechanism to evaluate ecological effects resulting from industrial and municipal point source inputs.
- CEA is the process of predicting the consequences of proposed developments relative to an assessment of existing environmental quality. It provides a science-based mechanism to evaluate the need for, and effectiveness of, pollution prevention practices and loci for adaptive management within a watershed.
- The CEA framework, coupled with an appropriate regional monitoring program, could also provide a future mechanism for linking aquatic quality information with land use development proposals, thus allowing for a comparison of existing and proposed developments relative to basin and regional planning objectives.
- NREI supported a number of studies that focused on issues of boreal forest conservation.

"Ecological Basis for stand management: A summary and synthesis of ecological responses to wildfire and harvesting in boreal forests" (Song, S.J. (ed.) 2002).

- The Alberta Research Council with support from the NREI completed a report comparing forest fires and forest harvest methods in terms of their effects on biodiversity at a stand level.
- The report assessed two strategies for forest management: management for old growth stages; and management to emulate natural disturbances, particularly wildfire.
- The ecological review encompasses the following subjects: forest structure and forest succession, soils, vascular and non-vascular plants, trees, woodpeckers and songbirds, and mammals. The report also provides: (1) a management rationale for the old-growth and natural disturbance approaches to forest management; (2) an adaptive management approach to forest management; and (3) an example of a natural disturbance template for forest management, based on an analysis of past fire activity.

"Spatial variation in bird communities in relation to coarse-scale environmental factors in Canadian boreal forest" (Hobson and Kirk, 2004).

- NREI supported a study that describes the biogeographical patterns in bird assemblages across the western Canadian boreal forest.
- Multi-variate statistical models that describe species distributions were developed based on different forest types, climate, environment and spatial location variables.
- A broad-based monitoring system is necessary to evaluate population trends in different taxa and population responses to anthropogenic landscape change. Currently

there is no such monitoring system in place for the Canadian boreal forest, although in Alberta the Alberta *Forest Biodiversity Monitoring Project* is a prototype.

- In the absence of monitoring programs, the impact of different landscape scenarios (including cumulative effects) can be modeled in a predictive fashion using information about species composition and abundance. Data collected as part of this study provide an opportunity to develop such models.

"Impact of land use on water balance and river discharge" (Granger, R. *et al.*, 2004).

- As part of the NREI, Environment Canada contributed to the development of a hydrologic model that can be used to assess the impacts of land use on the water balance and discharge in a watershed.
- The model was tested in the upper Paddle River, AB and demonstrated that, by converting 30% of the basin area from forest to agricultural and pasture lands, there is an overall increase in the basin snow water equivalent, a decrease in soil infiltration rate, resulting in a doubling of the basin runoff.

NREI Legacy

Formal arrangements such as Alberta's *Water Act* (1999), *Alberta Forest Conservation Strategy*, the *Regional Sustainable Development Strategy*, and the Mackenzie River Basin Board are examples of recent commitments by governments towards implementing integrated basin management approaches. Furthermore, in 2003 Alberta developed a comprehensive provincial water strategy focusing on safe and secure drinking water supply, health aquatic ecosystems, and reliable water supplies for economic development. There are a number of specific programs and cooperative arrangements which now facilitate integrated land use and water use planning and monitoring, such as: the Cumulative Environmental Management Association; the *Regional Aquatic Monitoring Program*; the Clean Air Strategic Alliance and the Network Centre of Excellence in Sustainable Forest Management.

Under NREI a new generation of planning and assessment tools have been developed or adapted to assist resource managers with integrated basin management: *Aquatic Cumulative Effects Assessment Framework*, and various hydrological, hydroclimatic and hydraulic models (eg. Cold Regions Hydrologic Model). As well, NREI has improved the predictability of existing models (Dissolved oxygen, contaminant transport, nutrient dynamics) through improved quantification of model variables. In contrast to NRBS, NREI addressed impacts of land use change on terrestrial ecosystems by investigating the inter-relationships between forest-stand and forest-bird communities. A consequence of this and other related forest initiatives (Ducks Unlimited's *Western Boreal Forest Initiative*) will be a broader consideration of biodiversity in forest management and decision-making.

NRBS RECOMMENDATION 9 (1996)

The government of Canada, the Northwest Territories, Alberta, British Columbia and Saskatchewan exercise their legislative powers to the fullest in preventing major diversions of basin water outside of the northern river basins.

Governments' response to the recommendation (1997)

Canada, Alberta, and the Northwest Territories will exercise their powers to the fullest to prevent major diversions of water out of the basin. In Alberta, the recently passed *Water Act* prohibits the transfer of water between major river basins. Also, the *Federal Water Policy (1987)* prohibits the export of water through inter-basin diversions.

NREI Progress Report 1 (1999)

- Alberta's *Water Act*, which came into affect on January 1, 1999, prohibits the transfer of water between major river basins as well as export of water.

NREI Progress Report 2 (2001)

- Legislation and/or regulations to prohibit bulk water removal have been implemented or under development by all provinces.
- Indian and Northern Affairs Canada is working with the territorial governments to implement a prohibition on bulk water removal.

NREI Update (2003)

- The Government of Canada continues to uphold its position on the prohibition of bulk water removal from major drainage basins in Canada.
- All western provinces have implemented regulations restricting the bulk removal of water.
- Indian and Northern Affairs Canada, as the authority with the jurisdiction for water management in the NWT, has developed a policy to prohibit bulk water removal from the major river basins of the Northwest Territories. This policy was developed in consultation with the Government of the Northwest Territories and was communicated to the Northwest Territories Water Board, the Gwich'in Land and Water Board, the Sahtu Land and Water Board, and the Mackenzie Valley Land and Water Board in spring 2003.

NREI Legacy

The governments of Canada, Alberta, and the Northwest Territories have demonstrated their commitment through various legislation and policies to prevent major inter-basin diversions of water.

NRBS RECOMMENDATION 10.1 (1996)

The Ministers direct action to be undertaken to protect the Smoky and Wapiti Rivers from further dissolved oxygen, nutrient and contaminant stress, and undertake to develop and apply reach-specific guidelines and associated regulatory requirements relevant to the small size of these rivers.

Governments' response to the recommendation (1997)

The governments concur with this recommendation and acknowledge the need to carefully manage water quality in this river system. Alberta has obtained reductions in loading to the Wapiti River for several contaminants, and is working with the City of Grande Prairie and the Weyerhaeuser pulp mill on further reductions. Any new developments on the Wapiti/Smoky River system will be subject to stringent discharge restrictions and will have to work with the existing facilities to ensure that water quality is protected.

In 1997, Alberta will initiate the development of a water quality management strategy for the Wapiti River, which will include reach-specific objectives for nutrients. Alberta is also preparing updated provincial water quality guidelines for other pollutants, which will be stringent enough to protect aquatic life in all rivers. Canada and Alberta, in cooperation with industry, will conduct further studies on the relationship among nutrients, dissolved oxygen, contaminants, and the biota in these systems.

NREI Progress Report 1 (1999)

- Alberta initiated water management planning for the Wapiti River following the proclamation of Alberta's *Water Act* in January 1999.
- Alberta undertook a review of new water quality guideline documents from both the Canadian Council of the Ministers of the Environment and the United States Environmental Protection Agency to ensure that water quality guidelines used in Alberta offer maximum protection for provincial rivers.
- Significant reductions in effluent loadings to the Wapiti River have been realized at the Weyerhaeuser Canada pulp mill since 1990.
- Studies were initiated under NREI to quantify nutrient contributions from the City of Grande Prairie's wastewater treatment facility (Recommendation 1.3).

NREI Progress Report 2 (2001)

- Colour continued to be an aesthetic issue in the Wapiti River and consequently the Weyerhaeuser Canada mill agreed to incorporate oxygen delignification (or equivalent) technology. Colour discharge limits will be decreased by 87% between 1990 and 2007.
- Progress continued on NREI nutrient and plant biomass studies (Recommendation 1.3).
- Dissolved oxygen research on the Wapiti River continued (Recommendation 2.1).

NREI Update (2003)

- Dissolved oxygen research, in which relationships between water column and pore water conditions were evaluated, has been completed on the Wapiti River (Recommendation 2.1).
- The City of Grande Prairie wastewater treatment facility was issued a new 10-year operating approval in 1999. The approval requires the facility to introduce Biological Nutrient Removal (BNR) and install ultra-violet disinfection by 2008 (Recommendation 1.3). These changes have significantly improved the quality of the treated effluent discharged to the Wapiti River. (Table 2) During this time, the daily average effluent flow increased from 10,673 m^3 to 14,031 m^3.
- Weyerhaeuser Canada Ltd. continues to focus on effluent improvement, and has implemented an oxygen delignification optimization process (Recommendation 1.4). This has reduced colour in the effluent by 15,000 kg/day (26%); reduced adsorbable organic halides (AOX) by about

Average Daily Concentrations	November 2000	February 2003	% Decrease
$CBOD_5$	6.3 mg/L	3.4 mg/L	46%
TSS	17.5 mg/L	3.2 mg/L	82%
NH_3-N	16.6 mg/L	6.6 mg/L	60%
TP	2.08 mg/L	0.16 mg/L	92%

Table 2

30%; and reduced COD by about 10%, even though pulp production increased slightly. Continuing refinements in production may also reduce effluent TSS and BOD concentrations. Total phosphorus loads have decreased by approximately 10% since 1995, whereas TN loads, mainly in the form of organic nitrogen, have increased by approximately 38% during the same period.

- A NREI Study has completed initial quantification of nutrient-algal relationships in the Wapiti River. (Recommendation 1.3).
- Environment Canada has also completed a study to identify and separate the effects of Weyerhaeuser's effluent from those due to Grande Prairie's municipal wastewater effluent. Algae, invertebrate animals and fish were evaluated using a stream mesocosm approach. Results indicate that response patterns in fish are different for sewage and pulp mill discharges, and that the impact of exposure to complex effluents on aquatic plants and animals is species-dependent.
- Alberta Environment has maintained two long-term water quality monitoring sites on the river, and also continued its enhanced nutrient and algal monitoring through the fall of 2002.

NREI Legacy

For the first time in these basins, a cumulative effects assessment approach (mesocosm studies) was applied in an attempt to separate the relative contributions and effects of municipal and industrial effluents. Resource managers now have a methodology to predict and understand multiple stressor impacts.

NREI's directed research has improved the understanding of the interactions between point and non-point nutrient and contaminant inputs, dissolved oxygen and resulting aquatic ecosystem productivity and health. Nitrogen and phosphorus guidelines have been proposed to guide future watershed nutrient management strategies for the Smoky-Wapiti systems. Significant advances to protect and enhance the water quality of the Smoky/Wapiti river systems have been made in the last five years by means of upgrades in municipal (biological nutrient removal at Grande Prairie) and pulp mill effluents (oxygen delignification at Weyerhaeuser Canada Ltd.). The new scientific information obtained during NREI along with the effluent improvements provide a solid basis upon which a future watershed management plan can be developed.

NRBS RECOMMENDATION 10.2 (1996)

Fish contamination and fish health effects be assessed for the populations of fish in the Slave River Delta ecosystem.

Governments' response to the recommendation (1997)

Canada and the Northwest Territories agree that deficiencies exist in our knowledge base concerning fish contaminants and fish health for the Slave River Delta fish populations. Therefore, they agree to conduct studies to address these information gaps. Through the cooperation and funding support of several federal government departments, contaminant investigations (metals, organochlorine compounds, and metallothionein) focusing on water, sediments and fish were conducted during 1996. The investigations will be completed and reports prepared by 1998/99.

Canada will maintain its food inspection program for fisheries to ensure that all commercially caught fish in the NRBS area meet human health consumption guidelines (Recommendation 12).

NREI Progress Report 1 (1999)

- Results of the *Slave River Environmental Quality Monitoring Program* were released in August 1998.
- Water, sediment and fish samples were tested for approximately 240 different chemicals, including those associated with pulp and paper mills, agricultural development, and oil and gas development. Results indicated very low levels of contaminants.

NREI Progress Report 2 (2001)

- Fish tissue data from the *Slave River Environmental Quality Monitoring Program* have been submitted to the Government of the Northwest Territories Health Department and to Health Canada for an assessment of human health implications.

NREI Update (2003)

- Contaminant analyses of burbot livers were completed, which include samples from the Slave River Delta (Recommendation 17.2).

NREI Legacy

Several aboriginal communities rely on the high quality of the Slave River Delta ecosystem and the ecological resources it supports. Results from both NREI and the Indian and Northern Affairs Canada's *Northern Contaminants Program* indicate that anthropogenic contaminants are detectable in fish tissue, pointing to the need for an ongoing basin-wide approach to water management. The MRBB have adopted such a philosophy and also recognizes the needs of First Nation people as part of this basin-wide water management approach.

NRBS RECOMMENDATION 10.3 (1996)

Monitoring activity be intensified in the reach of the Athabasca River from Hinton to below Whitecourt.

Governments' response to the recommendation (1997)

The governments of Canada and Alberta agree that this reach of the Athabasca River requires intensive surveillance. Accordingly, Alberta has expanded its monitoring in this reach to include more detailed surveys of nutrients and benthic algae, while at the same time maintaining the existing year-round networks of water quality and quantity stations, some of which are run in conjunction with the federal government. A report summarizing the results of this enhanced monitoring work will be produced in 1998.

Follow-up on PCB contamination will be done (Recommendation 13), and joint investigation of fish health in this reach will also be undertaken (Recommendation 15). As well, intensive monitoring in this reach is being undertaken by the pulp and paper mills in accordance with the federal *Pulp and Paper Mills Environmental Effects Monitoring Guidelines*, and provincial regulations.

NREI Progress Report 1 (1999)

- Intensive monitoring and investigations were maintained on the reach of the Athabasca River from Hinton to below Whitecourt to assess pulp mill and municipal effects.
- The McLeod River was sampled intensively during 1999 to support Alberta Environment's regulatory activities related to coal mines.
- Alberta Environment conducted investigations of nutrients and benthic algae along this reach between 1994 and 1998. These data will contribute to the development of nutrient guidelines for selected reaches of the northern river basins (Recommendation 1.3)
- NREI studies were implemented along this reach to investigate endocrine disruption in fish and nutrient-contaminant interactions (Recommendations 1.2 and 15.1).
- Monitoring of water quality, benthic algae, zoobenthos and fish populations was conducted in 1998 by the pulp and paper industry as required under provincial approvals, and the federal *Pulp and Paper Mills Environmental Effects Monitoring* (EEM) *Guideline*.

NREI Progress Report 2 (2001)

- Water quality and quantity monitoring continued on the reach of the Athabasca River from Hinton to below Whitecourt.
- Alberta Environment also continued nutrient and benthic algal monitoring during 2000.
- Fish, sediment and water samples were collected by Environment Canada and Alberta Environment during 2000 in support of NREI contaminants investigations in this reach (Recommendation 1.2).
- The five pulp mills along the Athabasca River reported to governments early in 2000 on water quality, benthic algae, zoobenthos and fish population studies conducted in accordance with the federal *Pulp and Paper Mill Environmental Effects Monitoring* (EEM) *Guideline*.

NREI Update (2003)

- An intensive level of research and monitoring activity has been maintained by governments in this reach of the Athabasca River. NREI research results discussed elsewhere in this report include topics such as endocrine disruption in fish (Recommendation 15.1); contaminants in water, sediments and biota (Recommendation 1.2); and nutrient/algal relationships (Recommendation 1.3).

- Ongoing monitoring activities include: annual reporting of river discharge by Water Survey of Canada; the annual *Alberta Water Quality Index* prepared by Alberta Environment (Recommendation 1.4); and pulp mill *Environmental Effects Monitoring* reports prepared by the pulp mill industry.
- The third cycle of EEM is in progress, with the Interpretative Reports due no later than April 1, 2004. Five of the seven mills on the Athabasca and Peace River systems had performed their Cycle 3 field work as of March 2003, and the remaining studies were performed in the fall of 2003. Sub-lethal toxicity and field survey data submitted to date by the mills can be viewed on the National EEM website: http://www.ec.gc.ca/eem/English/PulpPaper/

NREI Legacy

Surveillance of the Athabasca River water quality continued under NREI with intensive sampling and assessment of water, sediments and biota. In accordance with the federal *Pulp and Paper Mill Environmental Effects Monitoring program* and provincial approvals, additional water quality surveillance is provided on an ongoing basis. These data provide a strong foundation for the application of the aquatic cumulative effects assessment framework for this river system (Recommendation 8). This assessment framework can be readily updated as new information is obtained.

NRBS RECOMMENDATION 11 (1996)

The Alberta and Northwest Territories Governments invite representatives of the governments of Canada, British Columbia and Saskatchewan, municipalities, industry, universities, First Nations and other agencies involved in monitoring activities, in consultation with an advisory committee involving members of all stakeholder groups concerned with or affected by monitoring activities, to participate in an Integrated Ecosystem Monitoring Committee (IEMC). The role of the IEMC would be to coordinate and oversee technical and scientific aspects of water quality, water quantity and biota monitoring in the northern river basins to ensure minimal duplication of effort and greatest collective efficiency. The IEMC would adopt an ecosystem approach to environmental monitoring (see Synthesis Report #10).

Governments' response to the recommendation (1997)

The governments agree that an integrated monitoring committee is in the best interests of northern basins stakeholders and will refer this recommendation to the Board to be established under the *Mackenzie River Basin Transboundary Waters Master Agreement*. The Board would determine the membership of any such monitoring committee, taking into account the stakeholders and the agencies with monitoring responsibilities.

The Integrated Ecosystem Monitoring Committee would serve to coordinate and optimize aquatic ecosystem monitoring, particularly with regard to transboundary waters. The committee would identify issues and problems, promote standardization of methods, ensure quality control, minimize duplication, and provide for public input into the development of monitoring programs. It may set up expert subcommittees to deal with specific aspects such as hydrology, water quality, and fisheries. Governments would participate fully in such a committee, providing technical and scientific support, and would submit their monitoring programs to it for scrutiny and feedback.

NREI Progress Report 1 (1999)

- This recommendation was forwarded to the Mackenzie River Basin Board for review.
- An interim Monitoring Subcommittee was formed under the auspices of the Northern Rivers Ecosystem Initiative with representatives from the governments of the Canada, Alberta and the Northwest Territories.

- The interim Monitoring Subcommittee evaluated the various agency data collection programs and concluded that there was minimal overlap.

NREI Progress Report 2 (2001)

- The Mackenzie River Basin Board is in the process of evaluating monitoring requirements.
- Information on non-government monitoring programs currently active in the northern basins was reviewed (Recommendation 8).

NREI Update (2003)

- The Mackenzie River Basin Board has created a number of working committees to assist with the delivery of its responsibilities. A "Technical Committee" has been established to: coordinate information management within the basin; assess existing data; review issues of concern within the basin; identify data gaps; and ultimately to develop monitoring guidelines and programs.

NREI Legacy

The need for standardized and modern, basin-wide approaches to monitoring has been widely promoted by NREI, industry and others. NREI has developed, tested and applied new monitoring tools, which could be integrated into monitoring programs of government and industry. The notion of an Integrated Ecosystem Monitoring Committee to help achieve this is still valid as is a mechanism to better coordinate and integrate monitoring and research activities within the basins. In this regard, a Technical Committee to the MRBB has been struck and is overseeing the monitoring function, including the management of scientific and technical data. Through this committee there will be the opportunity to ensure a minimal duplication of monitoring effort and greatest collective efficiency by all levels of government.

NRBS RECOMMENDATION 12 (1996)

Alberta Health, Alberta Environmental Protection and Northwest Territories Health and Social Services, together with Health Canada and First Nations Health Authorities be charged with the responsibility of leading and coordinating the development of new, human health-based fish consumption policies, standards and guidelines for the Northern River Basins. This will require close collaboration and cooperation with other provincial, territorial and federal agencies, to rationalize and harmonize the extent of advisories across administrative boundaries. The process should build on the data and information generated by periodic surveys of fish contaminants. An improved mechanism should include the timely interpretation of findings, dissemination of information in a meaningful and culturally sensitive fashion, and contemporary population health risk assessment, risk management and risk communication concepts.

Governments' response to the recommendation (1997)

The Governments of Canada, Alberta and the Northwest Territories are cooperating to review the NRBS contaminant and dietary information for people who live within the basin, and to evaluate the applicability of the existing human health consumption advisories for the basins. The review of contaminant data by Canada and Alberta is underway and will be completed in 1997. The current fish consumption advisories will be amended as necessary. The review of fish consumption policies, standards and guidelines will involve First Nations and Métis communities and the results will be communicated directly back to them.

Canada and Alberta will design and implement routine fish-tissue testing programs for key species and reaches of the northern rivers. The data collected in these programs will be regularly evaluated against tissue consumption guidelines established for the protection of human health.

NREI Progress Report 1 (1999)

- A fish consumption advisory project was launched by Health Canada in partnership with the Treaty 8 Environmental Secretariat and Health Authority.
- Alberta Health and Wellness, and Alberta Environment began to evaluate: the most appropriate means of acquiring and handling fish contaminant data; and utilizing the data to prepare fish consumption advisories.

NREI Progress Report 2 (2001)

- Two reports were prepared in 2000 by the University of Alberta under contract to Alberta Health and Wellness to address risk communication issues related to Fish Consumption Advisories.
  - The first report was based on interviews with the public and focus group discussions.
  - The second report presented recommendations for fish consumption advisory protocols and communication activities.
- The Fish Consumption Advisory on the Wapiti/Smoky River basin was revised in November 2000 (Recommendation 1.2).
- The Fish Consumption Advisory for the Athabasca River near Hinton was reviewed in co-operation with Weldwood Canada.

NREI Update (2003)

- Alberta Health and Wellness (AHW) in collaboration with Alberta Sustainable Resource Development (SRD), Weldwood Canada and the Westview Regional Health Authority completed a review of the fish consumption advisory on the Athabasca River System, which had the following impact:
  - AHW subsequently removed the fish consumption advisory for the muscle tissue of mountain whitefish, burbot and bull trout in the Athabasca River, and its tributaries, in March 2002. The advisory was lifted after a scientific review and testing confirmed current levels of dioxins and furans in the fish were within Health Canada guidelines.
  - Concerns remain with regard to dioxin/furan levels in burbot liver taken from the Athabasca River system. As such, the ban on Burbot liver under the original *Fish Consumption Advisory* continues.
  - Bull Trout, which are now regulated by a "catch and release" program, were therefore not practically affected by these revisions. The advisory had previously recommended that anyone eating the fish restrict their consumption to one meal per week.
  - The existing mercury advisory on the Athabasca River for walleye is still in effect.
- The ban on the consumption of burbot livers from the Smoky and Wapiti rivers remains in effect primarily due to the high levels of PCBs, which affects the TCDD "toxic equivalents" calculation (Recommendation 1.2).
- The *Northern River Basins Food Consumption Survey*, initiated by the Treaty 8 Tribal Council Health Authority, has been completed and will be released in 2004.
- Alberta Treaty 8 Tribal Council Health Authority, with funding assistance from Health Canada, has initiated a fish tissue collection and analysis program in the northern river basins. The design and implementation of fish tissue testing protocols will be consistent with that which the province requires for issuing consumption advisories. Results of this fish tissue testing program will be used in conjunction with the results of the *NRB Food Consumption Survey* to develop a systematic human health risk assessment, which will identify safe fish consumption rates.
- Information on other NREI projects of relevance to contaminants in fish is reported under Recommendation 1.2.

NREI Legacy

An important legacy of the NRBS/NREI was bringing to light some of the issues of contaminants in the northern river basins. The reduction of contaminant concentrations has resulted in revisions to the fish consumption advisories for the Wapiti/Smoky River and Athabasca River basins, although there are still concerns associated with mercury in the Athabasca River. In addition, NREI partners have laid the foundation for a comprehensive Health Risk Assessment for fish consumption relative to the contaminants of concern. This was achieved as a result of collaboration with Treaty 8 Tribal Council, Health Canada, Department of Fisheries and Oceans, Alberta Sustainable Resource Development. This assessment will be based on the "*Northern River Basins Food Consumption Survey*" initiated by the Treaty 8 Tribal Council Health Authority in 2002, and on new contaminant data from 2003 and 2004. Report completion is anticipated by 2005. Fish consumption guidelines for First Nations communities within the northern rivers basin will be available at that time.

NRBS RECOMMENDATION 13 (1996)

The Ministers direct further investigation to be undertaken into defining the extent of PCB contamination and their sources in the Wapiti, Smoky, Peace and Athabasca river systems.

Governments' response to the recommendation (1997)

Canada and Alberta agree to undertake investigations of PCB contamination in the priority reaches identified by the Northern River Basins Study. Alberta is reviewing all NRBS data on this topic, and is undertaking a complete review of known PCB incidents, atmospheric transport and deposition phenomena, storage sites, and utilization sites in the northern basins (including British Columbia).

In consultation with the federal government, follow-up sampling is being designed and will be carried out in 1997 and 1998. A report on this work will be prepared in 1999. If significant PCB sources or problems are identified, remediation will be undertaken.

NREI Progress Report 1 (1999)

- A review of known PCB spills and contamination in the Wapiti River area was undertaken by Alberta Environment.
- Bottom sediments collected from the Wapiti/Smoky/Peace river systems during the autumn of 1997 all had concentrations well below the interim CCME guidelines for sediments.
- Low levels of PCBs were found in the sediments of the lower Wapiti and Bear rivers, which is consistent with the spatial pattern of contamination found in burbot livers during the NRBS.
- PCBs were not detected in samples collected by Alberta Environment in 1998 from the sewage effluent at Grande Prairie and from all Alberta bleached kraft pulp mill effluents.
- Environment Canada, with support from NREI, initiated a study to investigate PCBs and other contaminants in water, suspended sediment and bottom sediments obtained upstream and downstream of effluent discharge points, along specific reaches of the Peace-Athabasca system.
- Initial results from an NREI project conducted by Environment Canada suggested that there has been little decline in PCB levels in burbot liver compared to samples obtained during the NRBS, but other chlorinated organics (dioxins and furans) had declined.
- A government-industry workshop to exchange information on PCB contamination levels in the northern rivers was held in May 1999.

NREI Progress Report 2 (2001)

- Additional full-congener analyses for PCBs carried out by Alberta Environment in 1999-2000 on sediment samples from the Wapiti, Smoky, and Peace rivers were all well below CCME guidelines and confirmed the spatial pattern of PCBs reported previously.
- Higher PCB concentrations were found downstream of Grande Prairie than upstream and, in particular, the Bear River displayed elevated concentrations suggesting a potential urban source, although all samples remain well below interim CCME sediment guidelines.
- During the NRBS, elevated PCB concentrations in sediments were detected in the Peace River upstream of its confluence with the Smoky River. Sediment samples collected in 1999-2000 from both rivers near their confluence revealed negligible concentrations at either site, suggesting that the NRBS results showing elevated PCBs in the mainstem Peace River may have been anomalous.
- Sediment samples were obtained during the autumn of 2000 along the upper Athabasca River to investigate potential sources of low-level PCB contamination found in fish tissue during the NRBS.
- Additional sampling of water and suspended particles was planned for the upper reaches of the Athabasca River.

NREI Update (2003)

"Contaminants in water and suspended sediments from specific reaches of the Peace-Athabasca system" Alaee, M. *et al.*, 2004.

- PCBs were detected in low concentrations in all water samples collected from the Wapiti and Athabasca Rivers, and are similar to those found in more remote sites in the Mackenzie River and in Nunavut.
- PCB concentrations in water were typically less than 1.0 ng/L with the exception of Bear River on the Wapiti River system, which had an average concentration of 1.1 ng/L during the spring of 1999, and at Windfall on the Athabasca River, which had a concentration of 1.4 ng/L in June 2001.
- PCB concentrations in suspended sediment were typically less than 10.0 ng/g, with the exception of the site located on the Wapiti River near the CNR Bridge, which had concentrations approaching 18.0 ng/g. PCB concentrations in suspended sediment samples from the Bear River were also relatively high as compared to sites further upstream on the Wapiti River, possibly providing further evidence of a potential urban source.
- Suspended sediment from the Athabasca River, in general, had lower PCB concentrations than those found in the Wapiti River, typically less than 4.0 ng/g.

"Spatial and temporal trends of organochlorine contaminants in Fish from Alberta's northern rivers" Muir, D. and Fraikin, 2004.

- PCBs in burbot liver have shown little decline and remain relatively high in the Wapiti River downstream of Grande Prairie and, to a lesser extent, in the upper Athabasca River (Figure 11).
- PCB concentrations in muscle of mountain whitefish, bull trout and long nose sucker from the Athabasca river system are relatively low and similar to results from the same or related species elsewhere in northern Canada.
- The lack of a significant decline in PCBs in burbot liver at most locations may suggest a persistent source.

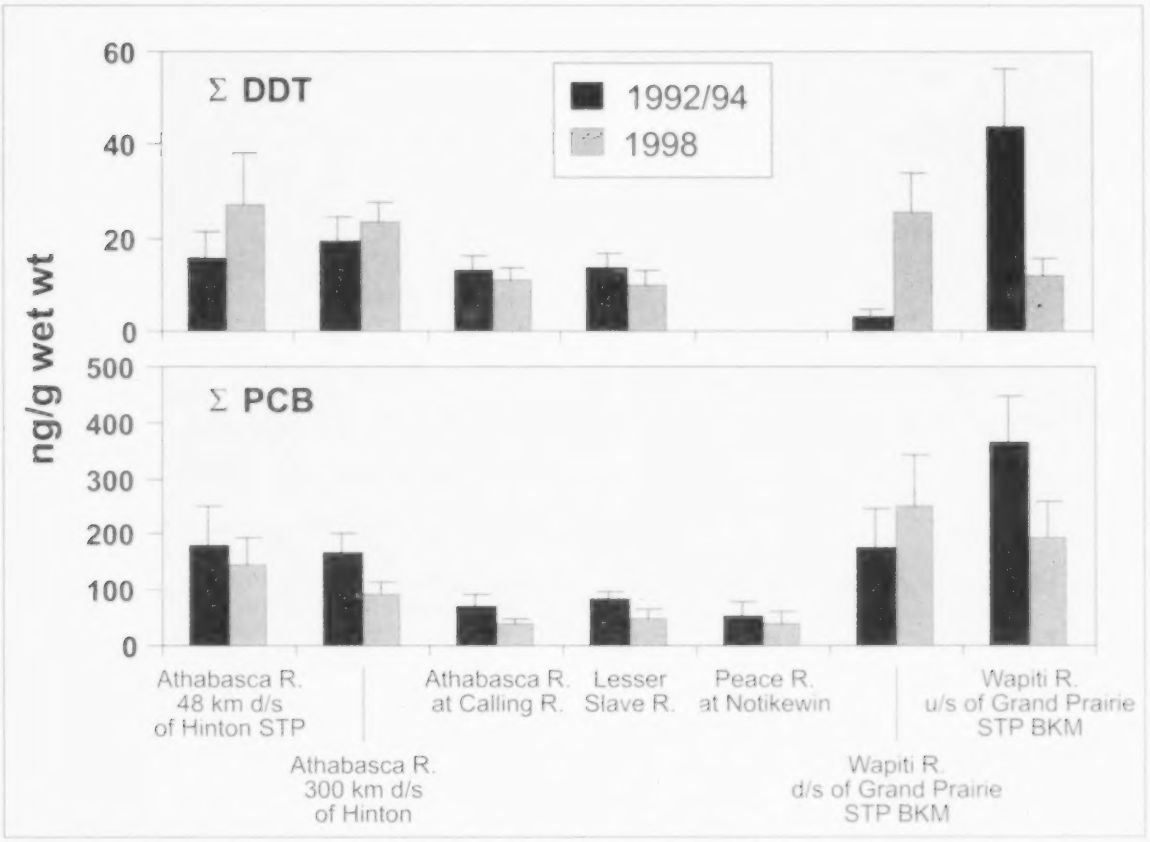


Figure 9 – *Temporal trends of ΣPCB and ΣDDT in burbot liver from the Athabasca/Peace/Wapiti river basins. Bars are geometric means (± 95% confidence intervals calculated with log transformed data). Results are for 1994 and 1998 except for the Wapiti River downstream of Grande Prairie (1992-1998) and the Peace River at Notikewin (1992-1999).*

NREI Legacy

Both the Northern River Basin Study (1991-1996) and the Northern Rivers Ecosystem Initiative (1998-2003) have provided important insights into the sources, abundance and distribution of PCBs. This knowledge will serve as a baseline for future comparisons to document trends over time.

Site-specific scientific evidence obtained through NREI has revealed that there are no active known point sources of PCBs to the Peace, Athabasca, Smoky or Wapiti river systems. However, past use, disposal and/or accidental release of PCBs may be partially responsible for the concentrations currently observed in sediments and fish from these systems. No known site of high contamination has been identified that would warrant clean-up action. River systems flowing through Grande Prairie and Hinton reveal that while there may be incidental, low-level contamination in and around urban/industrial centres, the concentrations in sediments are well below recommended CCME interim sediment quality guidelines. The findings of NREI also establish the need to better understand the role of long range transport and deposition of PCBs, and the influence of glacially derived water.

NRBS RECOMMENDATION 14 (1996)

The Ministers, for a five-year period following completion of the Northern River Basins Study, report annually on the progress of implementing the research and management recommendations of this Report to the Ministers and the synthesis reports; that the annual summaries clearly describe the results of the ongoing research and management initiatives; and that the report be made available to the general public.

Governments' response to the recommendation (1997)

The governments agree that reporting progress on implementing the responses to the recommendations is important. This task will be referred to the Board to be established under the *Mackenzie River Basin Transboundary Waters Master Agreement* (Recommendation 23). The results of research and management initiatives will be reported by the agencies responsible, and will also be made available to this Board.

NREI Progress Report 1 (1999)

- Progress report 1 was prepared in 1999 and distributed. Distribution to adjacent provinces and territories occurred through the Mackenzie River Basin Board (MRBB).
- The NREI web-site was established and linked to Environment Canada's National Program of Ecosystem Initiatives. www.pnr-rpn.ec.gc.ca/nature/ecosystems/

NREI Progress Report 2 (2001)

- A second Progress Report was prepared and distributed.
- Progress of the NREI was also provided in an NREI Newsletter, which was distributed, to basin residents.
- Several presentations were made on the NREI to First Nations communities and industry partners within the northern river basins.

NREI Update (2003)

- This NREI *Final Report* has been prepared outlining the achievements of the NREI relative to the commitments made by the Governments of Canada, Alberta and the Northwest Territories following the NRBS (Recommendation 1.6).
- A series of scientific reports was prepared to address many of the recommendations raised as part of the NRBS – these reports are listed in Appendix 2.
- An overall synthesis of the various technical reports was prepared for the basin residents – NREI *Synthesis Report*. This report summarizes the science conducted in the northern river basins as part of the NREI as well as other related initiatives that have occurred following the NRBS.

NREI Legacy

The results of the research and management initiatives undertaken since the NRBS have been reported through progress reports, newsletters, scientific and public meetings, and the final reports of NREI. The Mackenzie River Basin Board has assumed responsibility for ongoing communications of research and monitoring and other water management activities within the northern river basins.

NRBS RECOMMENDATION 15.1 (1996)

The Ministers initiate an intensive and comprehensive study of endocrine disruption and reproductive biology of fishes throughout the basins, and the implications for the fish populations and the integrity of the aquatic ecosystems.

Governments' response to the recommendation (1997)

The governments are concerned about endocrine disruption compounds, the lack of information about their sources and occurrence in these basins, and their potential effects on aquatic biota. Canada is addressing the issue of endocrine disruption and its implications to aquatic ecosystems on a national basis and will include the pulp mills and other sources in the Peace and Athabasca river basins within the study design. Alberta will support this work and industry cooperation will also be sought. Specifically, Canada will:

- conduct research into the development of bioassays capable of predicting the effects of pulp mill effluent on the reproductive biology of fishes;
- utilize the bioassays to identify the compounds responsible for the effects;
- identify pulp mill processes and technologies that generate these compounds;
- survey effluents nationally to describe the concentrations of the responsible compounds.

This assessment is targeted for completion by the year 2001.

Hormone Disrupting Substance: a substance having the ability to disrupt the synthesis, secretion, transport, binding, action or elimination of hormones in an organism or its progeny, that are responsible for the maintenance of homeostasis, reproduction, development or behaviour of an organism. (*Canadian Environmental Protection Act*, 1999).

NREI Progress Report 1 (1999)

- The study design was completed in 1998/99 and collaborative funding secured from the federal *Toxic Substances Research Initiative*.
- Development of new fish egg protein bioassays, to assess exposure to endocrine-disrupting compounds, was also initiated in 1998/99.

NREI Progress Report 2 (2001)

- Wild fish were collected from the Smoky-Wapiti river system during the fall of 1999.
- Examination of longnose sucker for evidence of responses to effluent sources indicated a significant nutrient response in both male and female fish downstream of the sewage effluent from Grande Prairie and from the discharge point from the Weyerhaeuser pulp mill. No presence of the intersex condition (eggs in the testes of male fish) was found downstream of these effluent discharge sites.
- Wild fish were also collected from four sites on the Athabasca River during the fall of 2000: a reference site above the Alberta Newsprint mill in Whitecourt; and exposure sites downstream of this mill but above the Millar Western Mill in Whitecourt; below the Millar Western mill; and further downstream below the sewage discharge for the town of Whitecourt.
- Preliminary results of a number of *in vitro* assays using effluent samples collected from all three pulp and paper mills participating in this study show indications of endocrine active compounds.

NREI Update (2003)

"Detailed endocrine assessments in wild fish within the Northern Rivers Basins" (McMaster *et al.*, 2004).

- Wild fish samples within these rivers, downstream of effluent discharge locations, demonstrate some endocrine

alterations relative to reference fish. These downstream changes were not considered significant compared to observations on fish from other sites across Canada.

- Municipal sewage discharges may be responsible for some of the reproductive changes, and nutrient enrichment responses may mask other endocrine alterations.
- Nutrient enrichment identified as part of this study corresponds well with effects described in *Cycle 2* reports for the *Environmental Effects Monitoring Program* for the Pulp and Paper Industry.
- Nutrient enrichment responses were not as pronounced at Whitecourt on the Athabasca River. However, other NREI-funded studies indicated that the reference sites used for wild fish in this study are also nutrient saturated due to inputs from the mill and sewage discharges from Hinton, further upstream.
- Based on results from the first two years of study, follow-up wild fish collections were conducted to see if responses found in 1999 could be replicated. These new studies demonstrated significant changes relative to those reported in 1999. It appears that changes made to the treatment processes at the Grand Prairie sewage treatment plant reduced the nutrient load released to the Wapiti River, subsequently reducing the reproductive effects demonstrated in 1999.
- A 21-day laboratory exposure to effluent from one mill location indicated no consistent effects on circulating steroid hormone levels or hepatic oxidative stress levels in immature rainbow trout.
- Laboratory extraction procedures on the specific mill furnish (consisting of 50% white spruce, 47% lodgepole pine and 3% balsam fir) from the Grande Prairie site were tested using a number of the *in vitro* endocrine assays. The results indicate that there are extracts active in all the assays tested suggesting that compounds within the wood may contribute to endocrine responses.

"Characteristics of EDCs at pulp mill sites in the Northern Rivers Basin". (Hewitt *et al.*, 2004).

- A complementary study, funded through the *Toxic Substances Research Initiative*, was undertaken in association with the wild fish assessments to characterize bioactive substances linked to ecological effects – specifically related to endocrine disruption. This was accomplished by screening effluents from the NRB mills for potential endocrine disruption using a number of *in vitro* endocrine assays, and by attempting to identify those effluent constituents functioning as endocrine disruptors.
- Extracted compounds from mill effluents were detected on fish hormone receptors, but there were no correlations of hormonal activity with the type of mill process used or the type of effluent treatment. Therefore it is unclear what effects, if any, conventional effluent treatment is having on levels of hormone active compounds in the effluents.
- Evidence of androgenic compounds in effluent, which contribute to endocrine disruption, were detected with the use of semi-permeable-membrane-devices (SPMDs). This is consistent with patterns observed at other mills across Canada.
- Extractions of wood chip feedstock sampled from the mill in Grande Prairie showed the potential of wood extractives to affect sex steroid signaling in fish. This information contributes to the body of evidence that suggests the sources of bioactive substances within the mill involve lignin, which is often the type of organic material in the final effluents.

NREI Legacy

Weight of evidence (gonadal morphology, maturation, male to female sex ratio, and circulating sex steroid levels) from the NRBS suggested the potential for endocrine disruption within the basins. However, NREI researchers observed minimal or no clear signs of endocrine disruption in fish downstream of pulp mills and municipal treatment plants. Researchers now hypothesize that eutrophication may mask the metabolic or endocrine response in fish and this could be a factor confounding the interpretation of effects measured at the NREI study sites. However, the existing body of knowledge, including NREI studies, has confirmed that lignin-derived substances arising from the digestion and bleaching of wood chips used in

the pulping process can affect sex hormone activity in laboratory and wild fish. Consequently there is a need for more sophisticated effects studies (e.g. mesocosm-based exposures) to confidently identify the causes of the observed effects in wild fish populations.

NRBS RECOMMENDATION 15.2 (1996)

The Ministers initiate a complementary study to assess the increased incidence of fish abnormalities in reaches immediately below pulp mills.

Governments' response to the recommendation (1997)

Canada and Alberta agree that the Northern River Basins Study results concerning the incidence of fish abnormalities below pulp mills warrant further study. Such studies will be undertaken collaboratively with industry and will attempt to make use of fish collected as part of the existing *Environmental Effects Monitoring* program prescribed under the federal *Fisheries Act*. The studies will be designed in 1997/98 and implementation will begin in 1998/99.

NREI Progress Report 1 (1999)

- Information on fish abnormalities was collected on the Athabasca and Smoky/Wapiti river systems by the pulp and paper industry as part of the federal *Environmental Effects Monitoring Program*.

The federal **Environmental Effects Monitoring (EEM)** program was instituted to evaluate the effects of pulp and paper mills on the aquatic environment to which their effluents are released. All pulp mills in Canada, which discharge to the aquatic environment, are required to participate in this program. Information from the program is used to assess the adequacy of the *Pulp and Paper Effluent Regulations* of Canada's *Fisheries Act* to protect fish, fish habitat and the use of fisheries resources.

NREI Progress Report 2 (2001)

- Data on the occurrence of fish abnormalities noted during field studies conducted under the *Environmental Effects Monitoring program* was presented in the EEM *Cycle 2 Interpretive Reports* submitted by the Athabasca River pulp mills, and by the Weyerhaeuser Grande Prairie mill, in March 2000.

NREI Update (2003)

- An examination of protocols used by various jurisdictions and institutions within Canada for collecting, handling and reporting information on fish tissue contaminants and abnormalities has been completed. Consistent protocols are typically in place for the collection and reporting of contaminant information as part of the regulatory effects monitoring.
- A review of information collected during the EEM *Cycle 2* revealed a subtle indication of increased fish abnormalities in some reaches of the Athabasca River. This information coincides with anecdotal evidence collected by area fisheries biologists.

NREI Legacy

The NREI was unable to resolve the fish abnormality issue reported during the NRBS. Based on new information collected under the EEM program, it is evident that abnormalities persist. Implications to fish health and populations remain an unknown, as are the causes of these abnormalities. Alberta will be developing a protocol for recording, reporting and handling information on the incidence of fish abnormalities as part of its Fisheries Management Information System. Moreover, additional effort will be applied to work with investigators collecting fish samples in the Wapiti-Smoky, Lesser Slave and Athabasca Rivers to record information on fish abnormalities.

NRBS RECOMMENDATION 16 (1996)

The Ministers draw on such expertise as necessary to undertake research on the effects on aquatic biota of exposure to substances arising from oil sands, both naturally and as a result of oil sands industry development, giving particular attention to establishing monitoring requirements.

Governments' response to the recommendation (1997)

The governments agree that, given the scale of the industrial developments in the oil sands area, it is necessary to improve our understanding about potential impacts to aquatic ecosystems. Governments will ensure that the relative importance of natural versus industrially-derived contaminants is examined.

In this regard, there are several completed and ongoing evaluations of industry, government, and universities on oil sands aquatic issues. These include surveys of existing aquatic conditions in the oil sands area, research on tailings pond reclamation, development of new technology to minimize tailings, research on oil sands-related contaminants in existing water bodies and tailings ponds, and evaluation of fish-tainting potential of wastewaters. A technical environmental advisory group of the Canadian Oil Sands Network for Research and Development, which includes industry, government, and universities, has been established to facilitate issue identification, research, coordination, and communication on this general issue. Several reports on these topics were released as part of the environmental impact assessments and applications recently submitted by Suncor Inc. and Syncrude Canada Ltd.

Alberta and Canada commit to maintaining a broad level of cooperative research, monitoring, and communication on this issue and to ensuring that industry is involved. This commitment to environmental protection is demonstrated by the recent Suncor Inc. Steepbank Mine development. The company conducted environmental research, described existing conditions, assessed impacts, and submitted the information as part of the impact assessment and application process under Alberta's *Environmental Protection and Enhancement Act*. After wide-ranging government and public review, residual issues were identified and requirements for further research and environmental effects monitoring were included in the Approval.

Alberta commits to applying this process to further oil sands developments. As well, Canada and Alberta will continue to conduct monitoring and research on the effects of oil sands developments, such as the ongoing contaminant and toxicity work under the federal *Panel on Energy Research and Development*.

NREI Progress Report 1 (1999)

- In 1998, Environment Canada, with funding support from Natural Resources Canada's *Panel on Energy Research and Development* (PERD), began a four year research project to assess the origins of oil sands contaminants in the surface waters and sediments of the lower Athabasca River.
- The oil sands industry established the *Regional Aquatic Monitoring Program* (RAMP) in 1997 to collectively carry out its aquatic survey and monitoring requirements.
- Representation on RAMP was expanded in 1998 to include federal and provincial governments, along with stakeholders from the region.
- Alberta Environment has developed a *Regional Sustainable Development Strategy* (RSDS) for the oil sands area.

NREI Progress Report 2 (2001)

- As industrial development of the Athabasca oil sands proceeds, all new projects are required to undergo formal review through Alberta's environmental assessment process.
- Environment Canada's program of research funded through PERD continues with the scope of the research focusing on 1) determination of the extent (spatial and temporal) and environmental effects of natural hydrocarbon releases to the aquatic environment; 2) distinguishing these effects from those produced by

refinery processes and related effluents; and 3) integrating these findings into an environmental monitoring and assessment framework for the oil sands industry.

NREI Update (2003)

- Environment Canada's research program on the impacts of oils sands development on the aquatic ecosystems of north-eastern Alberta, a companion study to the NREI, has concluded. Results of this research have indicated that:

"Oil Sands Final Summary Report: Assessment of natural and anthropogenic impacts of oil sands contaminants within the northern river basins" (Brua *et al*., 2003).

  - Tributaries passing through the Fort McMurray oil sands region contain significant levels of naturally derived hydrocarbons in the suspended sediment, likely derived from natural oil sand exposures along the banks of these rivers. Once the tributaries converge with the Athabasca River, dilution results in concentrations declining rapidly to values (< 0.01 $\mu g/g$), typical of remote pristine areas.
- Although sediments in the Athabasca River, its tributaries, downstream deltas and western Lake Athabasca indicate the presence of petrogenic PAHs, there is no evidence of impacts from the oil sands operations on hydrocarbon distributions.
- Exposure to naturally-occurring PAHs may have a slight to moderate detrimental effect on benthic invertebrates, as revealed by reduced survival and growth in laboratory toxicity tests.
- There appears to be an influence on fish reproductive indicators (decreased sex steroid production by testes and ovaries of slimy sculpin) in fish exposed to oil sands from the Steepbank River in the vicinity of anthropogenic disturbance. As well, metabolic bioindicators (e.g., mixed function oxygenase - MFO) in slimy sculpin showed differences between a site exposed to oil sands and a reference site.
- Semi-permeable membrane devices (SPMDs) indicated the presence of MFO-inducers in the Athabasca River, as well as potent inducers in refinery wastewater discharge. Additional studies are required to assess the ecological implications of these observations.
- Polycyclic aromatic compounds in bitumen froth, which is transported across the Athabasca River via pipeline, have relatively low mutagenic activity.
- Simulated spill response of bitumen froth from the pipeline crossing the Athabasca River suggests that the maximum likely concentration of representative polycyclic aromatic compounds in receiving waters will be less than 20 $\mu g/L$. Naphthenic Acids, however, were not predicted as part of this simulation.
- The water working group of CEMA is evaluating water quality variables of concern in the oil sands area, such as those variables mentioned above. CEMA wants to insure that water quality objectives and management systems are in place for the lower Athabasca River.

NREI Legacy

As a companion study to the NREI, the PERD research program, to date, has resulted in the production of over 35 publications and presentations dealing with the occurrence and impact of naturally occurring hydrocarbons within the oil sands region of north-eastern Alberta. The results provide strong evidence for: the presence of naturally occurring hydrocarbons in the lower reaches of the Athabasca River; a slight to moderate impact of these materials on local biota; and no evidence to indicate that local industries are contributing significantly to measured hydrocarbon levels or biotic impacts. The PERD study results will continue to influence the priorities, design and implementation of local monitoring programs (e.g., RAMP), and environmental assessments of proposed oil sands developments.

NRBS RECOMMENDATION 17.1 (1996)

A study be undertaken by the federal and territorial governments to determine the causes for physical changes in the Slave River Delta and their environmental impact. Elements of the study would include:

a) history of the Delta
b) recent changes to the Delta, including erosion and deposition processes
c) the influence of lake levels and shore processes to wind, waves, current and ice conditions; and
d) evaluation of the effects of the Bennett Dam, climatic factors and other natural causes on recent changes to the Delta.

Governments' response to the recommendation (1997)

In addition to its regular monitoring programs, Canada is undertaking new scientific investigations in 1997 on the Slave River Delta to address flow regulation and climate-related effects, the spatial distribution of erosional and depositional zones, and riverine processes in both the Delta and nearshore areas (Recommendations 7.1 and 17.2). The study will be completed by the year 2000.

NREI Progress Report 1 (1999)

- Environment Canada and Indian and Northern Affairs Canada began fieldwork in the Delta in 1997.
- Scientific collaboration was established with the University of Waterloo and Wilfred Laurier University.

NREI Progress Report 2 (2001)

- Several scientific investigations in the Slave River Delta have been completed and are being evaluated in the context of impacts that may be associated with the Bennett Dam (Recommendations 7.1 and 7.2).

NREI Update (2003)

"Hydro-climate impacts affecting the Peace-Athabasca-Slave Catchments and Deltas" (Prowse *et al.*, 2004).

- A water balance model was developed for Great Slave Lake to assist in evaluating the lake-delta interactions. The model confirms the importance of the climate-driven precipitation variability within Peace-Athabasca River system as the dominant control on lake levels.
- A naturalized flow analysis was coupled with the water balance model to assess the relative influence of climate versus that of flow regulation. Model results suggest that the climate and regulation impacts to the amplitude and peak of water level fluctuations in GSL have been offset by each other, and have cumulatively contributed to a shift toward an earlier peak water level (i.e., from early August to late June).

Seiche: a wave on the surface of a lake or landlocked bay; caused by atmospheric (wind) or seismic disturbances.

- Slope surveys within the Slave River Delta indicate that water level variations in GSL of 0.01-0.02 m would be sufficient to impact both the flow and fluvial processes in large portions of the active Delta. Fluctuations in water levels have historically been over 1.0 m with seasonal and inter-annual variability commonly approaching 0.5 m. Thus, lake seiche effects can potentially have a greater effect on the development of the Delta than any regulation-induced effect on the flow entering into the delta.

NREI Legacy

The Slave River Delta provides critical habitat for fish and wildlife as well as transportation routes and way of life for First Nations, Métis and other people living in this area. NREI has provided scientific evidence that Peace River flow regulation combined with climate

variability is influencing key hydrologic processes in both the Slave River Delta and Great Slave Lake. These effects have been manifested in changes to the amplitude of water level fluctuations and the magnitude of peak water levels. These effects are also cumulatively contributing to a shift towards earlier peak water levels in the lake. These results have important implications to understanding the effects of future changes in climate on natural processes such as sediment movement and deposition, flooding, spring ice jams, riparian vegetation succession, habitat use by fish and wildlife. This work further underscores the importance of taking a holistic approach to managing and protecting water resources on a watershed basis to meet human and ecological needs.

NRBS RECOMMENDATION 17.2 (1996)

The federal and Northwest Territories governments undertake a study of the limnology of Great Slave Lake with emphasis on sediment deposition and contaminant distribution.

Governments' response to the recommendation (1997)

Canada and the Northwest Territories agree that a limnological investigation of Great Slave Lake would be of value.

Canada will take the lead in the preparation of an environmental overview which will address the current understanding of the Great Slave Lake ecosystem. This report will be completed by 2000. Subsequent studies would depend on the results arising from the overview and consultations with stakeholders.

In addition, Canada has instituted new scientific investigations to specifically address contaminant transport and deposition within the Slave River Delta and nearshore areas. Further bottom sediment and fish samples will be obtained to investigate the concentration and effects of various contaminants identified during NRBS.

NREI Progress Report 1 (1999)

- A sediment transport and contaminant study was initiated in the Slave River Delta by Environment Canada and Indian and Northern Affairs in 1997, under the *Northern Contaminants Program*.

"Sediment-bound contaminant transport and deposition study in the Slave River Delta, Northwest Territories, 1997" (Milburn and Prowse, 1998).

- Results of this study indicated unique spatial and temporal characteristics of contaminants, with relatively higher concentrations of chlorophenolic, dioxin/furan and PCBs found in the distributary channels (particularly at the end of the ice covered season) as compared to the mainstem of the river or in the lakebed sediments.

NREI Progress Report 2 (2001)

- A bibliography of aquatic research conducted on Great Slave Lake since the 1940's was prepared in 2000.

NREI Update (2003)

"Spatial and temporal trends of organochlorine contaminants in Fish from Alberta's northern rivers" (Muir, D. and Fraikin, 2004).

- Analysis of burbot livers collected from the Slave River Delta revealed the presence of anthropogenic contaminants (toxaphene, PCBs and lindane).
- An environmental overview report on the aquatic ecosystem of Great Slave Lake was completed, based on existing data and information.
- Overall conclusions from the report suggest that the Great Slave Lake aquatic ecosystem remains in a relatively pristine

condition but that it is vulnerable to various stresses – most notably the influences of hydro-power development, fishing (commercial, sports and subsistence) and shoreline development in sensitive areas.

NREI Legacy

The Mackenzie River Basin has three great lakes: Athabasca, Great Slave and Great Bear. These remain poorly understood relative to the other great lakes of the world. The commitment by Canada and the Government of Northwest Territories to assemble the current knowledge about Great Slave Lake is an effort to identify where knowledge gaps may exist.

Results of this environmental overview of Great Slave Lake have indicated that the aquatic ecosystem remains relatively unimpacted. Studies have demonstrated that contaminants within the lake itself, associated with upstream developments, are either absent or barely detectable (e.g. compounds derived from pulp mill and oil sand industries). The presence of certain contaminants in the Slave River Delta sediments (e.g. PCBs, PAHs, dioxins/furans) and in burbot livers, collected from that area, point to the need to improve our understanding of their sources and ecological and human health implications.

The Great Slave Lake fishery continues to be healthy and an important economic opportunity for both commercial and recreational purposes. It is subject to ongoing management that may result in controls on commercial harvest, net restrictions, and altered catch limits in order to sustain the fishery (Recommendation 19).

Governments, aboriginal peoples and others are concerned about the vulnerability of the lake and delta ecosystems. This report will provide authorities with a valuable assessment of Great Slave Lake for use in regional planning and resource decision-making.

NRBS RECOMMENDATION 18 (1996)

Federal, provincial and territorial governments give priority to ensuring that scientific resources (including personnel) be maintained at levels necessary for long-term protection of the northern rivers and that the national granting councils provide increased funding for the support of multi-sectoral sponsored research on environmental problems through their various partnership programs.

Governments' response to the recommendation (1997)

Governments acknowledge that sound science is central to environmental policy and decision-making. Canada and Alberta are continuing their commitment to environmental research in the basins, as explicitly indicated in this report.

National granting councils, such as the Natural Sciences and Engineering Research Council, and the Province of Alberta are currently providing funding for joint university-government-industry research programs in the basins. For example, the National Centre of Excellence for Sustainable Forestry (led by the University of Alberta) was initiated in 1995-96 to examine forest management procedures and related ecosystem impacts. In 1996, Alberta announced the creation of the Forest Management Science Council to help integrate forest management research findings.

The *Alberta Environmentally Sustainable Agriculture Program* will continue to provide information concerning the effects of agriculture on aquatic ecosystems. Studies will continue in the watersheds of the Peace and Athabasca rivers.

Canada is conducting further research in the Mackenzie Basin under the *Panel on Energy Research and Development* (Recommendation 16), the *Northern Contaminants Program* and the *Global Energy and Water Cycle Experiment*.

In addition to the research outlined above, governments commit to the ongoing application of scientific and engineering resources to support regulatory and monitoring functions.

NREI Progress Report 1 (1999)

- Governments, industry, and universities allocated significant scientific research resources to improve the understanding of the effects of development on the northern river basins and to ensure the sustainability of the environment. This is particularly evident in the areas of petroleum resource extraction, forestry, and agricultural activities in the basins, as summarized under many of the recommendations in this report.
- Alberta Environment annually allocates $25 million to natural sciences research or to support related scientific activities to address environmental issues.
- In 1999-2000 the department allocated $1.7 million in direct funding for applied research into a variety of environmental issues through Air, Water, Land, Sustainable Ecosystems and Climate Change Research User Groups.
- Various industrial groups operating within the northern river basins also conduct a significant amount of aquatic monitoring and research. For example, oil sands companies are jointly investing approximately $0.7 million per year to fund the *Regional Aquatic Monitoring Program*.

NREI Progress Report 2 (2001)

- For the year ending April 2000, grants and scholarships from Canada's Natural Sciences and Engineering Research Council (NSERC) for research conducted in Alberta, much of it within the bounds of the northern river basins, exceeded $52 million. NSERC is the national instrument for making strategic investments in Canada's capability in science and technology.
- The *Mackenzie Global Energy and Water Experiment* (GEWEX) received renewed funding from NSERC for a five year period beginning in 2001. The NSERC funding of approximately $1 million per year is in addition to about $2 million per year in funding from federal government departments for this research initiative, which is studying the roles that water and energy play in the climate system of cold regions. The study, focused on the Mackenzie River Basin, began in 1992 and is part of Canada's contribution to a global study under the *World Climate Research Programme*.
- The *Sustainable Forest Management Network* is administered from the University of Alberta. The Network provides research support for the development of a total management protocol for Canada's Boreal Forest so it will be sustained in all its physical, biological, ecological and economic dimensions for future generations. This includes creating environmental technologies and management strategies for sustaining all values inherent in the boreal forest. For the year ending March 2000, Alberta researchers received $1.5 million of the $2.8 million in grants awarded nationally to the Network by NSERC.
- In March 2001, the federal government announced the formation of the *Canadian Water Network*, and provided $15 million in funding over 5 years. (Recommendation 3.2)
- In April 2001, NSERC announced $0.9 million in funding over four years for a Senior Industrial Research Chair in Integrated Landscape Management at the University of Alberta. The research team will seek science-based solutions that will promote environmental and industrial sustainability in Alberta. At the same time, a $0.8 million NSERC Collaborative Research and Development grant was announced. In partnership with Ducks Unlimited, supported by forestry companies Weyerhaeuser and ALPAC, and oil company Syncrude, a researcher from the University of Alberta will determine the effects of natural and human disturbances on wetlands, exploring the relationships between waterfowl, wetlands, landscape and climate.
- In May 2001, NSERC awarded $12.6 million for the establishment of the *Collaborative Mercury Research Network*. This national network involves 50 researchers from 14 universities and three research centers in seven provinces. The objective of the research is to improve our general understanding of how mercury is transmitted and accumulates in our ecosystems. Studies have revealed a rise

in mercury levels in a number of freshwater fish species. The network will attempt to assess the causes of this contamination and its possible health consequences.

NREI Update (2003)

- The second phase of the GEWEX MAGs has been underway since 2001. Although the fundamental goal of improving our understanding of the water and energy cycle of the Mackenzie River Basin has not changed, there has been a shift in emphasis from basic data collection and process research (Phase 1) to an emphasis on modelling and prediction (Phase 2).
- Environment Canada is in the early stages of launching the *Western Boreal Conservation Initiative* (WBCI). The WBCI is an effort directed at addressing: (1) the rate and extent of industrial development within the western boreal forest; (2) the need for conservation of boreal ecosystems and their biodiversity; and 3) a call from stakeholders within the western boreal forest for a greater presence by Environment Canada and its Canadian Wildlife Service.
- A Centre for Water Research located at the University of Lethbridge, which involves researchers from three universities in Alberta was launched in October 2003. The province of Alberta has provided $7.5 million over the next five years through its Ingenuity Fund. Research undertaken by the centre is expected to contribute to water management activities for Alberta.
- *Water for Life: Alberta's Strategy for Sustainability* was released in November 2003 and identifies support for knowledge and research as a key direction.

NREI Legacy

NREI and a variety of complementary initiatives (e.g., Toxic Substances Research Initiative, Northern Ecosystems Initiative, Boreal Ecosystem Conservation Initiative, Canadian Water Network, Panel on Energy Research and Development, Regional Sustainable Development Strategy, etc.) continued to illustrate the commitment by the federal, provincial and territorial governments to provide scientific resources to address deficiencies in our knowledge base surrounding environmental protection and conservation issues in the northern river basins.

Major economic developments (e.g. oil and gas, forestry, mining) that are occurring, and anticipated to grow within these basins, require that industry and governments continue to invest scientific resources to support environmental policy and decision-making. Securing long-term funding support for science may require the exploration of new innovative mechanisms (e.g. research consortia) at regional, national and international levels.

NRBS RECOMMENDATION 19 (1996)

The governments of Canada, Alberta and the Northwest Territories prepare a comprehensive review of the use, condition and sustainability of fish stocks in the Slave River basin and Great Slave Lake that are used for domestic and commercial purposes.

Governments' response to the recommendation (1997)

The governments agree with the need to monitor fish stocks. The government of Canada, with co-operation from the Northwest Territories, will prepare a comprehensive review of current knowledge on the use, condition, and sustainability of commercial fish stocks in the Northwest Territories portion of the Slave River Basin and in Great Slave Lake. Domestic fishery information, although much more limited, will also be reviewed.

Alberta monitors commercial fish stocks extensively and also shares information on domestic fisheries with users. This program will be maintained and expanded where feasible.

NREI Progress Report 1 (1999)

- The governments of Canada and the Northwest Territories work cooperatively with the Great Slave Lake Advisory Committee (GSLAC) on issues related to the management of the Great Slave Lake fishery.

NREI Progress Report 2 (2001)

- Jointly with the GSLAC, the federal Department of Fisheries and Oceans (DFO) has completed a study to determine the effects of changing the fishing net mesh size in the commercial fishery. The Department of Fisheries and Oceans has used this joint study to initiate a review of monitoring data from the fishery and to update information about catch composition and sizes.
- The Government of the Northwest Territories has developed a discussion paper on the Great Slave Lake fishery for public review, and is currently consulting with the GSLAC on a review of the use and condition of fish stocks in the commercial and recreational fisheries of Great Slave Lake.

NREI Update (2003)

- The DFO continues to co-manage Great Slave Lake Fish stocks with GSLAC.
- The DFO has completed a report evaluating the impact of gillnet mesh sizes on the whitefish commercial fishery and found that a reduction in mesh size should not reduce the sustainability of the fishery, especially if the present commercial quotas remain the same.

"Predicted impact of reducing gillnet mesh size on the efficiency of the Great Slave Lake Whitefish, *Coregonus clupeaformis* (Mitchill) fishery, Northwest Territories" (Day, A.C., 2002).

- A synoptic review of commercially harvested whitefish size and age trends (1972 to present) is currently underway by DFO.
- A review of the Buffalo River inconnu stock by DFO was initiated in 2003.
- Commercial fishery and Aboriginal food fishery harvest statistics collected since 1995 will continue.
- Efforts to sustain the recreational fishery of Great Slave Lake have resulted in a change in catch and possession limits for some areas of the lake, as well as the introduction of a barbless hook regulation during the winter of 2003.

NREI Legacy

The Government of Canada, with co-operation from the Government of the Northwest Territories and the Great Slave Lake Advisory Committee will continue to maintain vigilance on the harvest, stock status, and sustainability of commercial, subsistence and recreational (sport fishing) fish stocks in the Northwest Territories portion of the Slave River Basin and in Great Slave Lake.

NRBS RECOMMENDATION 20 (1996)

In light of the benefits to be gained through public involvement it is important that meaningful public participation be an integral part of the planning and development of future studies and their scientific programs.

Governments' response to the recommendation (1997)

The three governments recognize that the meaningful public participation initiated by the Study will continue to help all parties make better decisions for effective basin management. Canada, Alberta, and the Northwest Territories share responsibilities with all residents and sectors in the basins in managing the northern rivers and promoting sustainable development. Public involvement and open communication are explicit in federal and provincial operating guidelines. The Integrated Ecosystem Monitoring Committee under the Mackenzie River Basin Board (Recommendation 23) is expected to provide a forum for public input into the design of studies and monitoring programs.

NREI Progress Report 1 (1999)

- The numerous follow-up studies conducted through the Northern Rivers Ecosystem Initiative specifically address recommendations made to governments by the multi-stakeholder Northern River Basins Study Board.
- Information related to this follow-up work has been communicated to basin stakeholders through periodic newsletters.

NREI Progress Report 2 (2001)

- A NREI Internet web site was made available to the public as an additional source of information. www.pnr-rpn.ec.gc.ca/nature/ecosystems/
- Progress reports have been prepared providing an overview of how the NRBS recommendations are being met.
- Other initiatives underway in the basins, such as the *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area*, and the *Regional Aquatic Monitoring Program* are obtaining public input through more formal consultation processes.
- The Mackenzie River Basin Board hosted public meetings in Fort Smith in June 1999, and in Yellowknife in March 2001.

NREI Update (2003)

- Technical reports prepared as part of the NREI, which have addressed many of the NRBS recommendations, are available to basin residents.
- A NREI *Synthesis Report* describing the science conducted as part of the NREI, along with several other science/monitoring initiatives that have been ongoing within the basin, has been prepared. This *Final Report* is also a means of communicating to the basin residents the actions implemented by the governments to address the recommendations provided by the NRBS.

NREI Legacy

The three governments continue to advocate the importance of public participation in basin water management. There are several ongoing processes in place that facilitate public involvement in the management of environmental resources within the northern rivers basins (e.g., Mackenzie River Basin Board, Regional Sustainable Development Strategy, co-management boards, Cumulative Environmental Management Association, government-industry-university research partnerships, and other governance mechanisms).

NRBS RECOMMENDATION 21 (1996)

A valid and representative sample survey be conducted five years hence to assess changes in the use of the river basins and in the perceptions and attitudes of residents, providing a means of comparing public perceptions with realities at that time and providing guidance for policy development.

Governments' response to the recommendation (1997)

The governments agree that a survey would be valuable. This recommendation will be referred to the Board established under the *Mackenzie River Basin Transboundary Waters Master Agreement* for advice on survey design and implementation (Recommendation 23).

NREI Update (2003)

- This recommendation has been put forward to the Mackenzie River Basin Board for their consideration.
- One of the key responsibilities of the Mackenzie River Basin Board, as outlined in the *Master Agreement*, is to submit a report on the state of the aquatic ecosystem to the federal, provincial and territorial Ministers. This report has now been completed.
- An extensive consultation process was held throughout Alberta during 2001-02 to provide input into a provincial water strategy for Alberta. The final version of *Water for Life: Alberta's Strategy for Sustainability* was released in November 2003.

NREI Legacy

The original intent of this NRBS recommendation was for a comprehensive public opinion survey to be conducted every five years. Since the NRBS, other initiatives have overtaken the need for such an independent survey. For example, public opinions on water issues in Alberta were solicited in 2001-2003, and were subsequently used in the development of Alberta's *Water Strategy*.

Under the *Mackenzie River Basin Transboundary Waters Master Agreement* there is a requirement for a *State of the Environment Report* every five years. The process leading to its preparation includes input from various constituencies from which perceptions of issues and the state of the environment are obtained.

The need for an ongoing comprehensive survey every five years should be reconsidered in light of the public opinion surveys which are being conducted as part of other existing governance initiatives.

NRBS RECOMMENDATION 22 (1996)

The Ministers co-operate to establish, on a suitable financial basis, such new bodies as are needed to meet the present and future concerns about the aquatic and riparian ecosystems of Northern River Basins.

Governments' response to the recommendation (1997)

The governments agree that a mechanism is required to facilitate basin-wide water management. The governments therefore agree to cooperate to establish a Board under the *Mackenzie River Basin Transboundary Waters Master Agreement* as the body to address many of the issues concerning the aquatic and riparian ecosystems of the northern river basins (Recommendation 23).

NREI Legacy

In response to the need to address recommendations made by the NRBS, governments established the Northern Rivers Ecosystem Initiative. Moreover, the Mackenzie River Basin Board was established in 1998, and is jointly funded by Canada, Saskatchewan, Alberta, British Columbia, Yukon, and the Northwest Territories.

NRBS RECOMMENDATION 23 (1996)

23.1 All reasonable efforts by the Ministers be directed to the earliest possible signing of the Mackenzie River Basin Transboundary Waters Master Agreement, *and the establishment of that Board.*

23.2 Membership of any new board or panel related to the affairs of the northern river basins be kept small but appointed to represent federal, provincial and territorial governments, First Nations, municipalities, industry, environmental interests, residents and other stakeholders without dominance by any one constituency or interest group.

23.3 The method of appointment for each member be acceptable to the constituency to be represented by the member.

23.4 An advisory board, to be called the Northern River Basins Board (NRBB), be created jointly by the governments of the jurisdictions covered by the northern river basins, to advise governments on matters related to the aquatic and riparian ecosystems of the northern river basins.

23.5 If the NRBB is established as recommended, the Integrated Ecosystem Monitoring Committee (IEMC) as described in Monitoring Recommendation 11-1 should be closely linked to NRBB, possibly reporting to the NRBB.

Governments' response to the recommendation (1997)

The governments agree with the need for a prompt establishment of a Mackenzie River Basin Board. Canada, Alberta, the Northwest Territories, Saskatchewan, British Columbia, and the Yukon have all signed the *Mackenzie River Basin Transboundary Waters Master Agreement* under which such a Board will function. The Board will be a cooperative forum in which governments in the basin could develop consistent and cooperative management approaches and resolve interjurisdictional issues. The governments propose that the Mackenzie River Basin Board serve the purpose of the recommended Northern River Basins Board, thus avoiding the duplication and cost of having two boards.

NREI Legacy

The establishment of the Mackenzie River Basin Board and its subsequent activities has fulfilled all elements of the commitments made by the governments in the above response.

NRBS RECOMMENDATION 24 (1996)

A steering committee be established by the governments of Canada, Alberta and Northwest Territories to facilitate a transition, by April 1, 1997, from the NRBS to other bodies with successor functions.

Governments' response to the recommendation (1997)

Since the release of the NRBS *Report to the Ministers*, a federal-provincial-territorial task force has been struck to develop an integrated, considered response to the NRBS findings and recommendations. As well, the governments have completed the signing of the *Mackenzie River Basin Transboundary Waters Master Agreement* and are working to establish the Board under that *Agreement*. The federal-provincial-territorial task force will facilitate the transition to that Board.

NREI Progress Report 1 (1999)

- The federal-provincial-territorial task force was replaced with a steering committee established by the governments of Canada, Alberta and the Northwest Territories in June 1998. This steering committee managed the implementation of the commitments made by Ministers in their *Response to the Northern River Basins Study*.
- This Northern Rivers Ecosystem Initiative Steering Committee includes membership from the government departments who have primary responsibilities for undertaking the follow-up actions: Environment Canada; Indian and Northern Affairs Canada; Health Canada; Alberta Environment; Alberta Sustainable Resource Development; Alberta Health and Wellness; and the Northwest Territories Department of Resources, Wildlife and Economic Development.
- The Committee reports to a group of three senior officials consisting of: the Regional Director-General of the Prairie and Northern Region of Environment Canada; the Deputy Minister of Alberta Environment; and the Deputy Minister of the Department of Resources, Wildlife and Economic Development of the GNWT.
- The Mackenzie River Basin Board, also established in 1998, is committed to ensuring that the water resources of the Mackenzie River Basin are managed in a sustainable manner.

NREI Progress Report 2 (2001)

- The NREI Steering Committee communicates regularly with the Mackenzie River Basin Board to ensure all NRBS recommendations are being satisfactorily addressed.

NREI Update (2003)

- This final progress report outlines how the NRBS recommendations have been met and provides, where appropriate, an explanation of ongoing commitments by the governments with regard to stewardship of the northern river basins.

NREI Legacy

An Executive Steering Committee of senior representatives from Environment Canada, Alberta Environment and NWT Department of Resources, Wildlife and Economic Development was established to oversee the governments' response to the NRBS. It subsequently established the Northern Rivers Ecosystem Initiative. With the establishment of the Mackenzie River Basin Board, the completion of the NREI studies, and release of the NREI *Synthesis* and *Final Reports*, the NREI is complete and the Steering Committee has been discharged.

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN1 (1996)

Governments establish a committee, that will involve communities and other stakeholders, to consult, advise and implement resulting programs and projects which are the outcome of the recommendations from the Northern River Basins Study, so that the interests and rights of the First Nations/Métis are safeguarded and protected.

Governments' response to the recommendation (1997)

The governments agree that people most directly affected by water policies and programs should have the opportunity to provide input to the development and implementation of them. *The Mackenzie River Basin Transboundary Waters Master Agreement* and associated bilateral agreements will provide important mechanisms for this and other purposes. First Nations/Métis will be represented on the Board under this *Agreement*.

NREI Progress Report 1 (1999)

- The *Mackenzie River Basin Transboundary Waters Master Agreement* was signed in 1997 and the Mackenzie River Basin Board established, with membership on the Board including First Nations/Metis representatives from each of British Columbia, Alberta, Saskatchewan, Yukon and the Northwest Territories.
- First Nations/Métis people have also been consulted on initiatives such as the development of the *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area*.

NREI Progress Report 2 (2001)

- Representatives of the NREI have met with First Nations/Métis groups in the northern river basins on several occasions to inform them of the initiative and to advise them of progress.

NREI Update (2003)

All newsletters and progress reports produced over the course of the NREI have been provided to the First Nations/Métis groups within the northern river basins.

NREI Legacy

All reports produced during the NREI, including this *NREI Final Report* and the *NREI Synthesis Report* have been provided to the MRBB for broader distribution through their representative members including the First Nations/Metis groups within the northern river basins.

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN2 (1996)

The governments develop a government to government relationship with First Nations/Métis governments concerning implementation of northern river basins strategies and recommendations.

Governments' response to the recommendation (1997)

The governments are committed to First Nations and Métis involvement in the implementation of the NRBS recommendations. The *Mackenzie River Basin Agreement* will be an important mechanism for involving First Nations/Métis peoples; however, other mechanisms will also be used as appropriate to address specific recommendations. For example, the document *An Understanding on First Nations/Alberta Relations* of November 10, 1995 sets a framework in which Alberta deals with First Nations signatory to the document. Similarly, the *Alberta/Métis Framework Agreement* signed August 16, 1993 sets a framework in which the province interacts with the Métis Nation of Alberta Association.

NREI Progress Report 1 (1999)

- The *Mackenzie River Basin Transboundary Waters Master Agreement*, which recognizes the needs, concerns and rights of Aboriginal Peoples, has been signed and the Mackenzie River Basin Board has been established. The membership on the Board includes a First Nations/Métis representative from each province and territory which is signatory to the agreement.
- The document *Strengthening Relationships - Alberta Government's Aboriginal Policy Framework* is available on the internet at: http://www.aand.gov.ab.ca/PDFs/final_strengthrelations.pdf. The *Framework* outlines Alberta's commitment to foster and participate in cooperative relationships and partnerships with First Nation, Métis and other aboriginal communities and people.
- Aboriginal Peoples are involved in the implementation of NRBS recommendations through initiatives such as training of water treatment plant operators. As well, Aboriginal Peoples are represented on the Peace-Athabasca Delta Environment Committee, and have been consulted during the development of the *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area*.
- In the Northwest Territories, co-management land and water boards under the *Mackenzie Valley Resource Management Act* have been established. These co-management boards regulate the use of settlement and Crown lands and water by issuing land-use permits and water licenses.

NREI Update (2003)

- *Water for Life: Alberta's Strategy for Sustainability* was developed following more than 18 months of consultation with Albertans, including Aboriginal communities. Two Aboriginal Focus Group meetings were hosted in 2002/03 by Alberta Environment and Aboriginal Affairs and Northern Development. Representatives from the Aboriginal community were also present during other stages of development of *Water for Life* including the Ideas Group (2001), Ministers Forum on Water (2002), and the Water Strategy Workshops (2003).

NREI Legacy

The governments recognize the benefit gained by the involvement of First Nations and Métis in the implementation of the NRBS recommendations. The governments are committed to the continued involvement of First Nations and Métis people in the ongoing stewardship of the northern river basins. The *Mackenzie River Basin Transboundary Waters Agreement* will continue to be an important mechanism for involving First Nations/Métis peoples along with their direct involvement as stakeholders in ongoing initiatives such as the *Regional Sustainability Development Strategy*. Co-management boards, which involve First Nations/Métis people, will continue as a process for managing and regulating land and water use in the Northwest Territories.

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN3 (1996)

An ecosystem management approach be used which includes all aspects of the watershed management and encompasses the commitment of First Nations/Métis people to the ecosystem approach.

Governments' response to the recommendation (1997)

The governments support and will use an ecosystem management approach. This is one of the fundamental principles behind the *Mackenzie River Basin Transboundary Waters Master Agreement* and of the operational policies of Canada, Alberta, and the Government of the Northwest Territories.

NREI Legacy

As required under Alberta's *Water Act*, which came into force in January 1999, a *Framework for Water Management Planning*, and a *Strategy for the Protection of the Aquatic Environment* has been prepared. The *Framework* and *Strategy* include specific reference to aquatic ecosystems, and watersheds are recognized as the fundamental management unit.

Discussions are currently underway with regard to *Water for Life: Alberta's Strategy for Sustainability*, with the province promoting a model of shared governance, principally at a watershed scale. An Ecosystem management approach continues to be one of the fundamental principles behind the *Mackenzie River Basin Transboundary Waters Master Agreement*.

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN4 (1996)

Any future research programs developed or endorsed by the governments or research organizations be encouraged to focus on the integration of scientific and traditional knowledge within a First Nations/Métis research protocol.

Governments' response to the recommendation (1997)

The NRBS has demonstrated the importance of traditional knowledge. The governments encourage the integration of traditional and scientific knowledge in research programs. The *Mackenzie River Basin Transboundary Waters Master Agreement* calls for the incorporation of traditional knowledge and values in the conduct and actions of the Board.

NREI Legacy

The Mackenzie River Basin Board was established in 1998, and has made a commitment to consider the needs and concerns of Aboriginal Peoples through "*the incorporation of their traditional knowledge and values*[1]." The governments continue to encourage the integration of traditional and scientific knowledge in research programs as well as with all future stewardship activities within the northern river basins. The Mackenzie River Basin Board will continue to seek First Nations/Métis input through Aboriginal representatives on the Board.

[1] *Mackenzie River Basin Transboundary Waters Master Agreement (1998)*

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN5 (1996)

The northern river research strategies endeavour to enable First Nations/Métis communities and governments to initiate and carry out scientific research which answers First Nations/Métis environmental questions about the northern river basins.

Governments' response to the recommendation (1997)

The governments endorse the participation of First Nations/Métis communities in strategies for environmental research. As in the NRBS, it is important that research programs are designed to include the concerns of First Nations/Métis people. Governments are committed to working with First Nations/Métis people to initiate and carry out scientific activities. The *Mackenzie River Basin Transboundary Water Master Agreement* and associated bilateral agreements provide mechanisms through which such an objective can be achieved.

NREI Progress Report 1 (1999)

- An example of incorporating First Nations/Métis involvement in scientific research is the Fish Consumption Advisory project undertaken by the Alberta Treaty 8 Health Authority in conjunction with the Treaty 8 Environmental Secretariat and Health Canada – see Recommendation 12.

NREI Progress Report 2 (2001)

- The Mackenzie River Basin Board hosted a Water Forum in Yellowknife in March 2001 where Traditional Ecological Knowledge was integrated with contemporary scientific knowledge in each of the workshop sessions.

NREI Update (2003)

- The report on the *Northern River Basins* (NRB) *Food Consumption Survey*, which was coordinated by the Treaty 8 Health Authority and involved eight other First Nations and Health Canada, is expected to be released in 2004 (Recommendation 12). The Treaty 8 Health Authority intends to build on the information gained from this survey and is proposing to test for contaminants in the fish most commonly consumed by NRB residents. The fish contaminants data coupled with information from the survey will be evaluated in the context of a health risk assessment to determine whether fish are safe to eat and, if so, what amount can be safely consumed (Recommendation 12).

NREI Legacy

The governments continue to endorse the participation of First Nations/Métis communities in strategies for environmental research. It is clear the First Nations/Métis are proactive in initiating environmental research, which governments will continue to support. As previously indicated the bilateral agreements associated with the *Mackenzie River Basin Transboundary Waters Master Agreement* will also be an important mechanism in achieving this objective.

NRBS FIRST NATIONS/MÉTIS RECOMMENDATION FN6 (1996)

Governments commit to a cooperative and participatory thrust of future research in the northern river basins focusing on human health and its link to environmental contaminants or ecological change, and the cause and effect relationship of environmental contaminants or ecological change to the health of the communities and peoples involved; particular effort should be placed on the quality of water within the region encompassed by the Northern River Basins Study boundaries.

Governments' response to the recommendation (1997)

The governments agree with co-operative and participatory research, and the need to examine potential linkages between human health and environmental conditions. Their commitment to this is demonstrated by the Northern River Basins Human Health Monitoring Program, being completed by Alberta Health. This study is examining the situation carefully, and will identify knowledge gaps or deficiencies and make recommendations accordingly. Governments are committed to reviewing the findings and addressing the recommendations.

NREI Progress Report 1 (1999)

- Alberta received the final report and recommendations of the *Northern River Basins Human Health Monitoring Program* in April 1999, but has not yet released a response to the recommendations.
- Human health/environment-related initiatives were undertaken through the Northern Rivers Ecosystem Initiative and include projects dealing with fish-consumption guidelines and drinking water (Recommendations 3.1 and 12).

NREI Update (2003)

- Ongoing monitoring of health issues related to environmental factors is the mandate of the regional health authorities and is delivered through the environmental health programs.
- Alberta Health and Wellness (AHW) facilitate this activity by providing resources (e.g., Ft. McMurray and Grand Prairie community exposure and health effects programs) and a province-wide perspective for surveillance and monitoring.
- AHW established a province-wide monitoring program for *Cryptosporidium* spp. and *Giardia* spp. Through the Provincial Laboratory for Public Health (Microbiology) a new, improved testing methodology has been developed for the detection of these water-borne pathogens.
- Through the Center for Toxicology located at the University of Calgary, a methodology has been developed for analyzing pesticides in drinking water, common air pollutants, and biomarkers. Province-wide surveillance has been enhanced to include environmental health as part of monitoring, as reported in the document "*Health Trends in Alberta, 2000*."
- Grants have been provided by AHW to the public health laboratories for developing new monitoring tools and testing methodologies for common environmental pollutants that are important from a human health perspective.
- Health surveillance is now conducted as part of a collaborative network including the Regional Health Authorities, Alberta Cancer Board, non-government agencies such as the Clean Air Strategic Alliance, and within specific initiatives such as the Community Exposure and Health Effects programs.

NREI Legacy

Continued efforts are still required in examining and evaluating the potential linkages between human health and environmental conditions, whether from contaminants or other environmental change. The governments continue to support co-operative and participatory research in the northern river basins as it relates to human health and the environment.

Appendix 1

SUMMARY OF GOVERNMENT ACTIONS

The following table cross-references the actions to be taken in response to the Northern River Basin Study (NRBS) recommendations, the relevant recommendation number(s), and the page number in this Progress Report. The actions are grouped under the main headings from the recommendations section of the NRBS report. The lead government is also indicated.

NRBS Heading and Government Actions	Relevant NRBS Recommendations and Page Number	Lead Government
BASIN MANAGEMENT		
Endorse the National Commitment to Pollution Prevention	1.1.....page 07	All
Continue to reduce persistent toxic substances	1.2.....page 13	Alberta
Minimize nutrient discharges from pulp mills; implement tertiary treatment at large municipalities and at Jasper	1.3.....page 17 2.4.....page 32 2.5.....page 34 10.1.....page 52	Alberta and Canada
Apply the *Industrial Effluent Limits Policy*	1.1.....page 07 1.2.....page 13 1.3.....page 17 1.4.....page 22	Alberta
Negotiate international agreements to control airborne pollutants	1.5.....page 26 1.1.....page 07 1.2.....page 13	Canada
Determine winter dissolved oxygen requirements for aquatic life	2.1.....page 28	Canada
Adopt the 6.5 mg/L dissolved oxygen guideline	2.2.....page 30	Alberta
Implement the ENVIRODAT data base	2.3.....page 31	Alberta
Maintain and improve drinking water programs	3.1.....page 36 3.2.....page 38	All
Implement the provisions for integrated land and water planning under the Alberta *Water Act*	1.3.....page 17 4 .....page 39 5 .....page 40 8 .....page 46 9 .....page 51	Alberta
Prevent major diversions of water out of the northern river basins	9 .....page 51	All
Evaluate the 1996 floods in the Peace-Athabasca Delta and develop action plans	7.1.....page 42 7.2.....page 45	Alberta

NRBS Heading and Government Actions	Relevant NRBS Recommendations and Page Number	Lead Government
REACH-SPECIFIC ISSUES		
Develop a water quality management strategy for the Wapiti River, including reach specific nutrient objectives	1.3.....page 17 2.3.....page 31 2.5.....page 34 10.1.....page 52	Alberta
Initiate contaminant investigations in the Slave River Delta	10.2.....page 54 17.2.....page 69	Canada
Increase monitoring in the Hinton-Whitecourt area of the Athabasca River	10.3.....page 55	Alberta
MONITORING		
Enhanced monitoring and establishment of an integrated ecosystem monitoring committee	11 .....page 56 18 .....page 70 20 .....page 74	All
Improve nutrient and BOD monitoring	2.3.....page 31	All
Monitor non-point source effects on aquatic ecosystems	1.1.....page 07 8 .....page 46	All
Review the NRBS fish contaminant data and consumption guidelines, and implement long-term monitoring of contaminants in fish tissue	1.2.....page 13 12 .....page 57 18 .....page 70 FN6 .....page 82	Alberta and Canada
RESEARCH		
Initiate follow up investigations on PCB contamination	1.2.....page 13 10.1.....page 52 10.3.....page 55 13 .....page 59	Alberta
Conduct further research on nutrient-DO-contaminant effects on biota	1.3.....page 17 2.5.....page 34 10.1.....page 52 10.3.....page 55	Canada and Alberta
Investigate endocrine disruption and abnormalities in fish	15.1.....page 63 15.2.....page 65	Canada and Alberta
Maintain research and communication on environmental aspects of oil sands development	16 .....page 66 18 .....page 70	Alberta
Evaluate hydrologic-climatic relationships in northern deltas	7.1.....page 42 17.1.....page 68	All
Initiate studies on the evolution of the Slave River Delta, the limnology of Great Slave Lake, and contaminant transport and deposition in both.	10.2.....page 54 17.1.....page 68 17.2.....page 69	Canada
Review knowledge on commercial fish stocks in Great Slave Lake and the NWT portion of the Slave R. Basin	19 .....page 73	Canada

NRBS Heading and Government Actions	Relevant NRBS Recommendations and Page Number	Lead Government
PUBLIC PARTICIPATION		
Involve, and report to, the general public and First Nations on various initiatives on a regular basis	1.3.....page 17 1.6.....page 28 14 .....page 62 20 .....page 74 21 .....page 75 FN1 .....page 78 FN2 .....page 79	All
Develop new ways of publicizing enforcement actions	6 .....page 40	All
SUCCESSOR ORGANIZATION		
Work to implement the MRB *Agreement* and establish its Board.	7.2.....page 45 11 .....page 56 14 .....page 62 20 .....page 74 22 .....page 76 23 .....page 76 24 .....page 77 FN1 .....page 78 FN2 .....page 79 FN6 .....page 82	All
FIRST NATIONS/MÉTIS		
Use an ecosystem management approach	FN3 .....page 80	All
Include traditional and scientific knowledge, as per the *Mackenzie River Basin Agreement*	FN4 .....page 80 FN5 .....page 81	All
Complete the Northern River Basins Human Health Monitoring Program	FN6 .....page 82	Alberta

Appendix 2

Northern Rivers Ecosystem Initiative Project Reports

Project Theme	Technical Report Title	Author (s)
Hydrology-Climatology		
	Impact of land use on water balance and river discharge	Granger, R.J., N. Hedstrom and T. Brown
	Monitoring Delta ecosystem response to water-level restoration	Pietroniro, A. and J. Töyrä
	Modelling climate change impacts on water availability in the Peace-Athabasca catchment and Delta	Pietroniro, A., F.M. Conly, B. Toth, R. Leconte, N. Kouwen, D.L. Peters and T.D. Prowse
	Hydro-climatic impacts affecting the Peace-Athabasca-Slave catchment and deltas	Prowse, T.D., S. Beltaos, B. Bonsal, T. Carter, M.C. English, T. Gardner, J.J. Gibson, D.L. Peters and L. Romolo
Contaminants		
	Contaminants in Water and Suspended Particles from Specific Reaches of the Peace-Athabasca System	Alaee, M., M. Lowen, R. Crosley, J. Buonomo and D. Muir
	Contaminant biomagnification in specific reaches of the Peace-Athabasca River ecosystem - Study Highlights	Evans, M.S. and D. Muir
	Spatial and temporal trends of organochlorine contaminants in fish from Alberta's northern rivers	Muir, D. and C. Fraikin
	Atmospheric Contribution to Mercury Loading in the Northern Aquatic Systems	Wiens, B.J., M. Kellerhals and A.D. Pankratz
Endocrine Disruption		
	Characterizations of EDCs at pulp mill sites in the Northern River Basins	Hewitt, L.M., M.E. McMaster, M. Kohli, A. Pryce, J.L. Parrott, G.R. Tetreault and G.J. Van Der Kraak
	Detailed endocrine assessments in wild fish within the Northern River Basins	McMaster, M., L.M. Hewitt, G.R. Tetreault, J.L. Parrott, G.J. Van Der Kraak, C.B. Portt and N. Denslow

Project Theme	Technical Report Title	Author (s)
Nutrients/ Dissolved Oxygen		
	Setting Nutrient Guidelines for the Northern Rivers of Alberta	Chambers, P. and M. Guy
	Review of available information and guidelines for dissolved oxygen in northern rivers	Meding, M., J.M. Culp and N.E. Glozier
	Dissolved oxygen relationships of water column and pore water habitat: Implications for guideline improvements	Culp, J.M., N.E. Glozier, M. Meding, L.I. Wassenaar, F.J. Wrona, G. Koehler and D. Halliwell.
	Mesocosm Assessment of Pulp Mill and Municipal Sewage Effluent Effects on Benthic Food Webs and Longnose Dace (Rhinichthys cataractae) of the Wapiti River, Alberta	Culp, J.M., M.G. Dubé, K.J. Cash, N.E. Glozier, D. MacLatchy and R.B. Brua.
Cumulative Effects		
	An Annotated Bibliography on Cumulative Effects Assessment in Northern River Ecosystems	Brown, J., D.D. MacDonald, K.J. Cash and J.M. Culp
	Development of a cumulative effects assessment framework for aquatic ecosystems: the Northern Rivers Ecosystem Initiative demonstration project	Dubé, M.G., J.M. Culp, K.J. Cash and K.R. Munkittrick
	Implementation of a cumulative effects assessment framework for northern Canadian rivers using decision support software	Dubé, M.G., J..M. Culp, K.J. Cash, K.R. Munkittrick, B.N. Johnson, J. Inkster, G.W. Dunn, B. Johnston, W.G. Booty, I.I.W. Wong, D.C.L. Lam, O. Resler and A.M. Storey
Biodiversity		
	An Investigation of Migrant Shorebird Use of the Peace Athabasca Delta, Alberta in 1999	Beyersbergen, G.W.
	Peace-Athabasca Delta Waterbird Inventory Program: 1998-2001 Final Report	Butterworth, E., A. Leach, M. Gendron, B. Pollard and G.R. Stewart
	State of the aquatic environment Peace-Athabasca Delta - 2002	Donald, D.B., W. Aitken, J. Syrgiannis, N.E. Glozier, F.G. Hunter and M.R. Gilchrist
	Spatial variation in bird communities in relation to coarse-scale environmental factors in Canadian Boreal Forest	Hobson, K.A. and D.A. Kirk
	Ecological Basis for Stand Management: A summary and Synthesis of Ecological Responses to Wildfire and Harvesting in Boreal Forests	Song, S.J.(editor)

Project Theme	Technical Report Title	Author (s)
Great Slave Lake		
	Evaluation of the Vulnerability of the Great Slave Lake Ecosystem	MDA Consulting Ltd.
Other Contributed Reports related to NREI		
	Oil Sands Final Summary Report: Assessment of Natural and Anthropogenic Impacts of Oil Sands Contaminants within the Northern River Basins	Brua, R.B., K.J. Cash and J.M. Culp
	Investigation of poly-chlorinated biphynols in bottom sediments of the Bear-Wapiti-Smoky-Peace and upper Athabasca river systems, 1989-2000	Hazewinkel, R. and L. Noton
	Sediment-Bound Contaminant Transport and Deposition Study in the Slave River Delta, Northwest Territories, 1997	Milburn D. and T.D. Prowse
	Pollution Prevention opportunities in road building and heavy construction industry in Alberta	Earth Tech Canada Inc.
	Alberta ground cover characterization project summary 2002	Sanchez-Azofeifa G.A., S. Hamilton, M. Kachmar and S. Rudyk

Canada

Alberta

Northwest Territories